

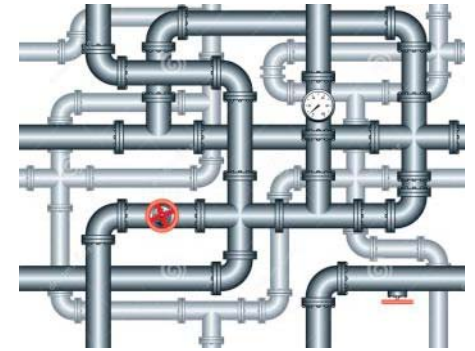
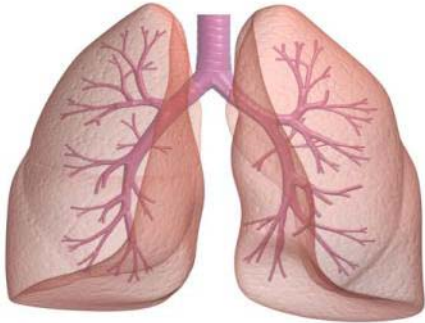
ECMO

OXIGENACIÓN POR MEMBRANA EXTRACORPÓREA

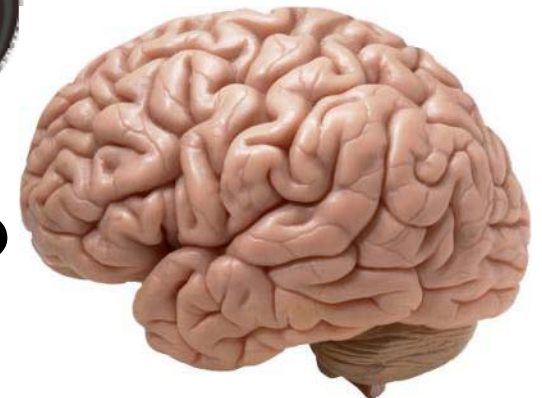
Rodolfo Keller
Coordinador de ECMO
Hospital Universitario Austral



¿Qué es ECMO?



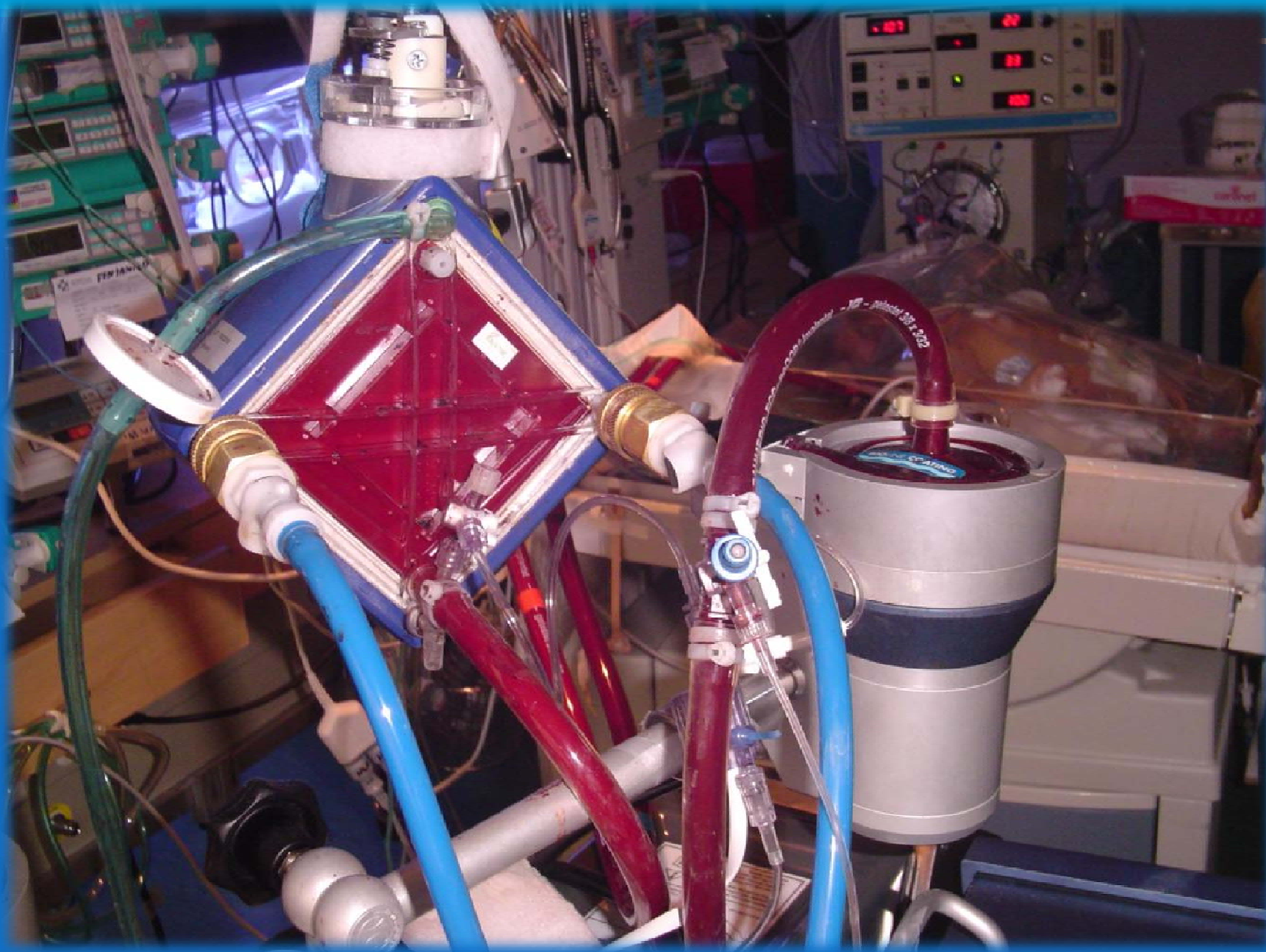
¿cómo funciona?



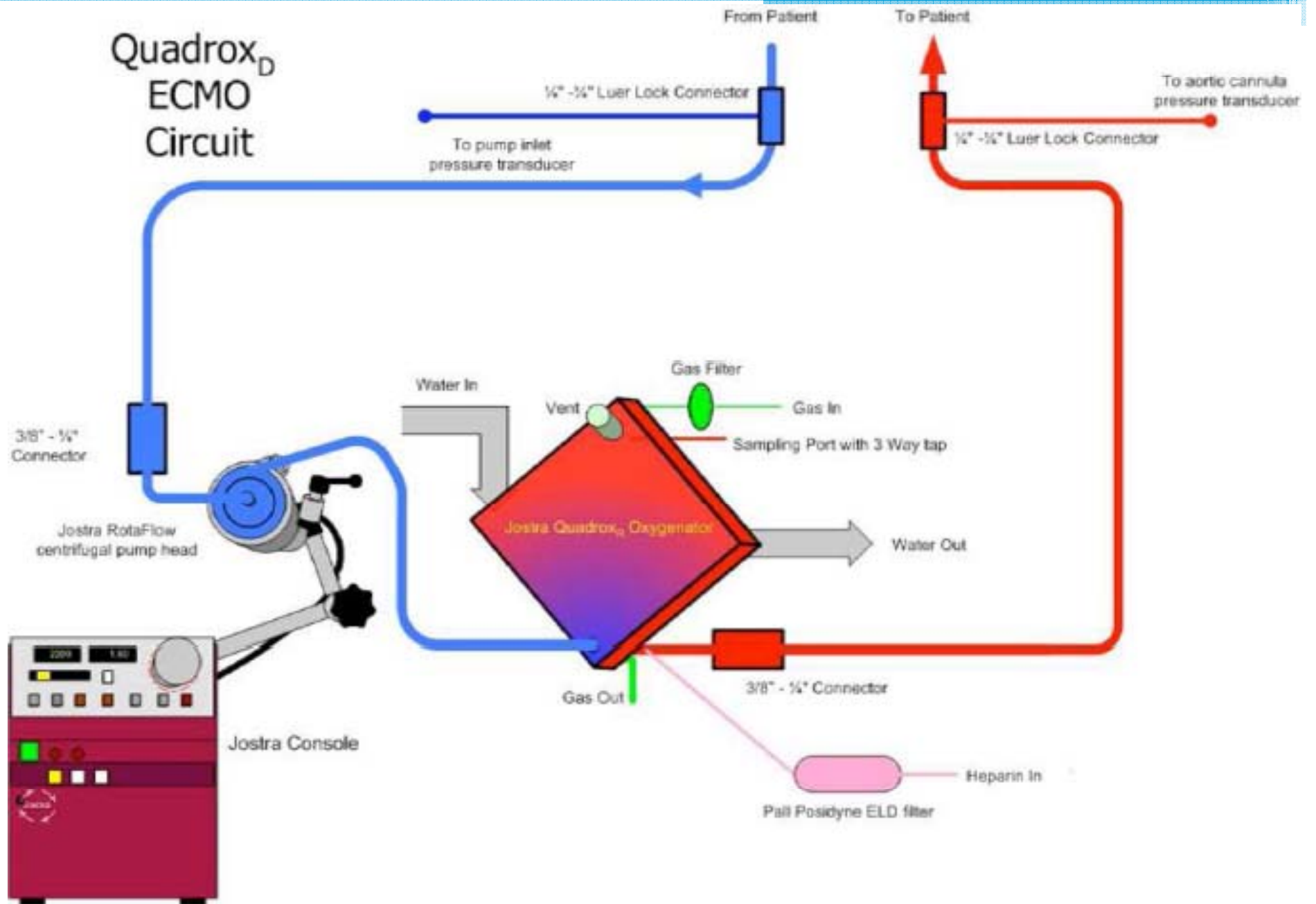
Definición

ECMO es el equipo capaz de reemplazar parcial a totalmente la función pulmonar, cardíaca e incluso renal en forma transitoria.

Está especialmente destinado a pacientes extremadamente graves (80% de mortalidad) que están fracasando a pesar de ser asistidos con la máxima terapéutica disponible y que sufran de enfermedades potencialmente reversibles.



Quadrox_D ECMO Circuit





2 modalidades de ECMO

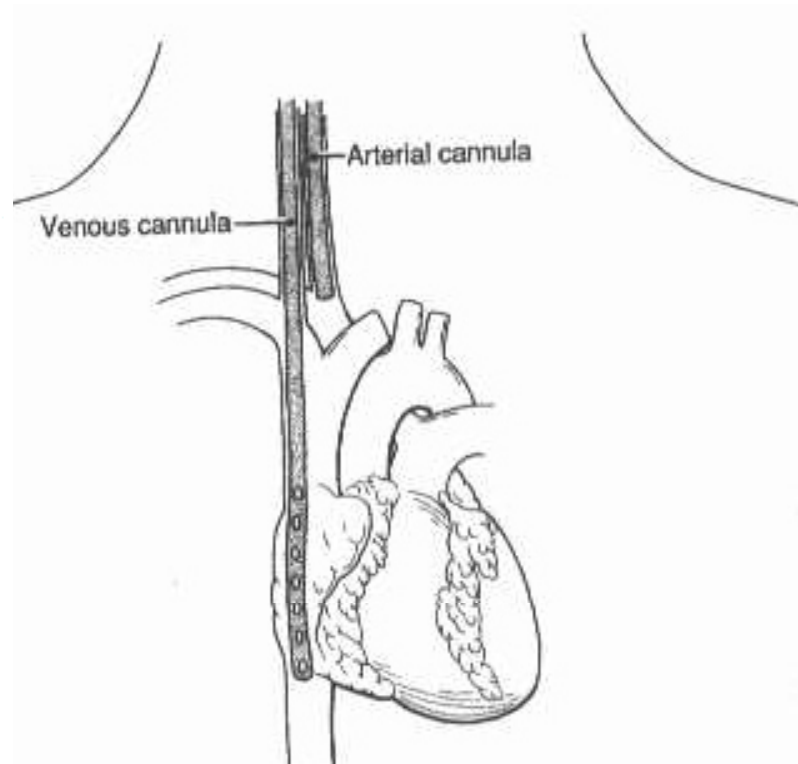
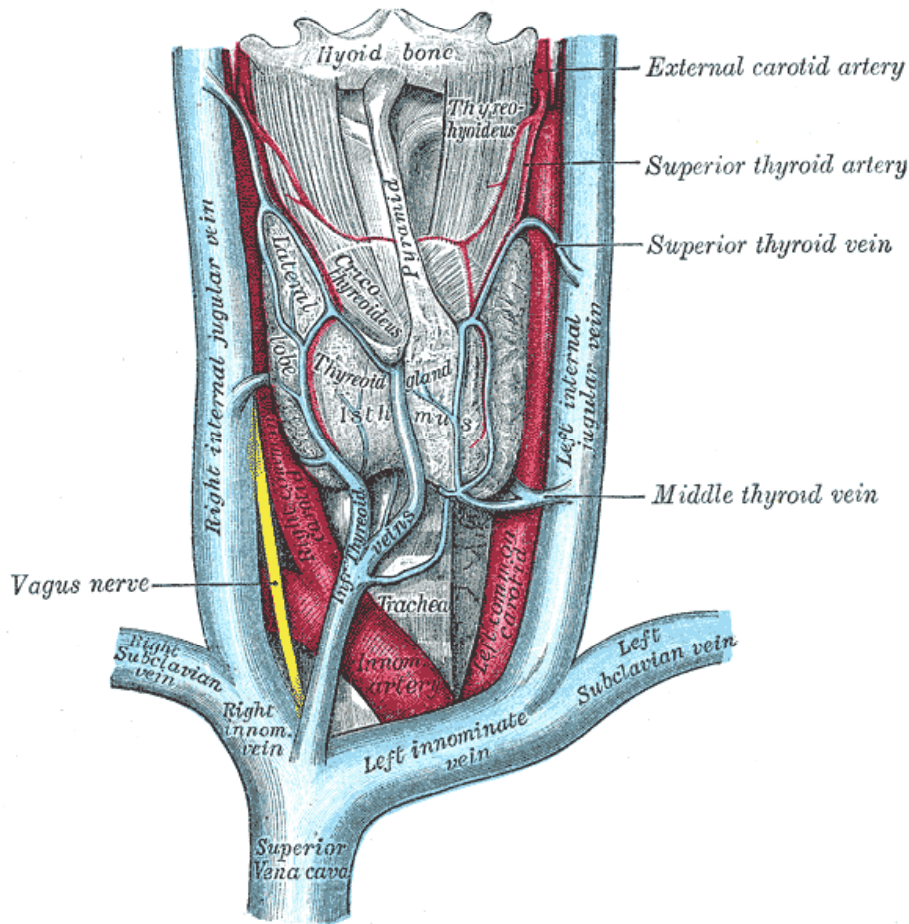
Veno arterial

- Ventajas:
 - Soporte cardíaco directo
 - Excelente entrega de O₂
 - Rápida estabilización
- Desventajas
 - Ligadura de carótida
 - Flujo No pulsátil
 - Hiperoxia cerebral posible
 - Menor O₂ miocardio
 - Émbolos a la circulación sistémica

Veno venoso

- Ventajas:
 - Respeta arteria carótida
 - Flujo pulsátil
 - Flujo pulmonar normal
 - Perfusión miocárdica con sangre oxigenada
 - Émbolos al lecho pulmonar
- Desventajas:
 - No soporte cardíaco directo
 - Recirculación
 - Menor entrega de O₂

Acceso Vascular Neonatal



Acceso Vascular Neonatal



Acceso Vascular Neonatal





ECMO

Manejo del paciente

Post ECMO

¿Cómo pasar del pre al post?



<http://www.else.org/resources/Guidelines.aspx>



Extracorporeal Life Support Organization (ELSO)

GUIAS PARA LA INSUFICIENCIA RESPIRATORIA NEONATAL

ELSO

El registro internacional reporta un 85% de sobrevivencia al ECLS y un 75% de sobrevivencia al alta en neonatos

¿cómo reducir ese 10% de diferencia?

DECANULACIÓN

- Suspender heparina 30 a 60 minutos antes
- Ligadura de vasos
- VV vs. VA
- Arteria carótida
- Evitar embolia aérea

Cuidados específicos post ECMO

- Neurológicos:
 - EEG
 - Sat regional (NIRS)
 - Ecografía cerebral
 - Doppler vasos del cuello
- Hematológicos
- Nutricionales
- Infectológicos



ELSO SUGERENCIAS PARA EL SEGUIMIENTO DE PACIENTES POST ECMO

ELSO RECOMMENDATIONS FOR FOLLOW-UP FOR ECMO PATIENTS

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<https://www.elseo.org/Portals/0/IGD/Archive/FileManager/2440a82ecdcusersshyerdocumentselseorecommendationsforneonatalpediatricecmopatientsfollowup.pdf>

ECMO

RESULTADOS Y COMPLICACIONES



ECLS Registry Report

International Summary

January, 2015

Extracorporeal Life Support Organization
 2800 Plymouth Road
 Building 300, Room 303
 Ann Arbor, MI 48109

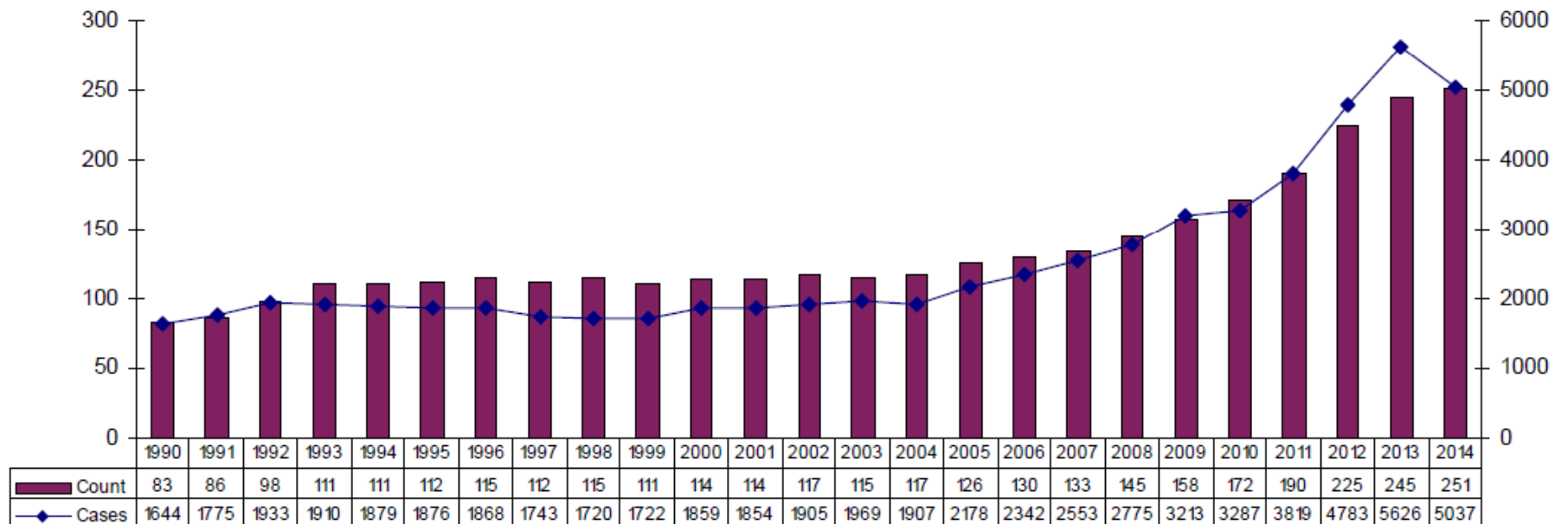
Overall Outcomes

	<i>Total Patients</i>	<i>Survived ECLS</i>		<i>Survived to DC or Transfer</i>	
Neonatal					
Respiratory	27,728	23,358	84%	20,592	74%
Cardiac	5,810	3,600	62%	2,389	41%
ECPR	1,112	712	64%	449	40%
Pediatric					
Respiratory	6,569	4,327	66%	3,760	57%
Cardiac	7,314	4,825	66%	3,679	50%
ECPR	2,370	1,313	55%	976	41%
Adult					
Respiratory	7,008	4,587	65%	4,026	57%
Cardiac	5,603	3,129	56%	2,294	41%
ECPR	1,657	639	39%	471	28%
Total	65,171	46,490	71%	38,636	59%

CENTROS ECMO

Centers

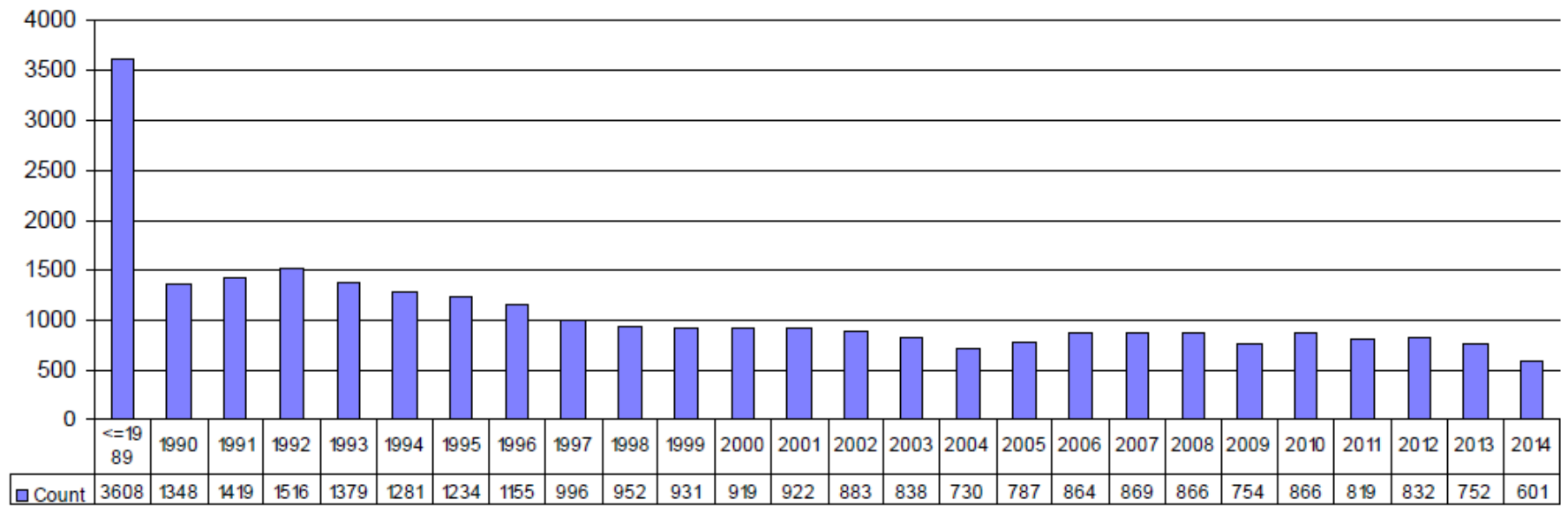
Centers by Year



ECMO NEO 1990 a 2014

Neonatal Respiratory (0-30 days)

Annual Respiratory Neonatal Runs



Neonatal Respiratory Runs by Year

	<i>Annual Runs</i>	<i>Cumulative Runs</i>	<i>Average Run Time</i>	<i>Longest Run Time</i>	<i>No. Survived</i>	<i>% Survived</i>
<=1986	820	820	118	840	659	80%
1987	653	1,473	121	411	558	85%
1988	1,016	2,489	131	673	841	83%
1989	1,119	3,608	134	500	917	82%
1990	1,348	4,956	144	672	1,095	81%
1991	1,419	6,375	153	827	1,141	80%
1992	1,516	7,891	153	1,200	1,181	78%
1993	1,379	9,270	158	959	1,096	79%
1994	1,281	10,551	161	936	973	76%
1995	1,234	11,785	163	794	932	76%
1996	1,155	12,940	166	1,176	842	73%
1997	996	13,936	173	1,131	742	74%
1998	952	14,888	187	1,093	683	72%
1999	931	15,819	183	812	673	72%
2000	919	16,738	188	936	694	76%
2001	922	17,660	190	949	655	71%
2002	883	18,543	190	944	624	71%
2003	838	19,381	195	1,001	551	66%
2004	730	20,111	196	956	473	65%
2005	787	20,898	205	1,006	532	68%
2006	864	21,762	208	1,033	578	67%
2007	869	22,631	198	1,229	582	67%
2008	866	23,497	214	1,133	579	67%
2009	754	24,251	212	1,327	514	68%
2010	866	25,117	203	2,549	598	69%
2011	819	25,936	216	1,175	542	66%
2012	832	26,768	209	1,843	584	70%
2013	752	27,520	208	959	496	66%
2014	601	28,121	209	1,111	399	66%

Run time in hours. Survived = survival to discharge or transfer based on number of runs

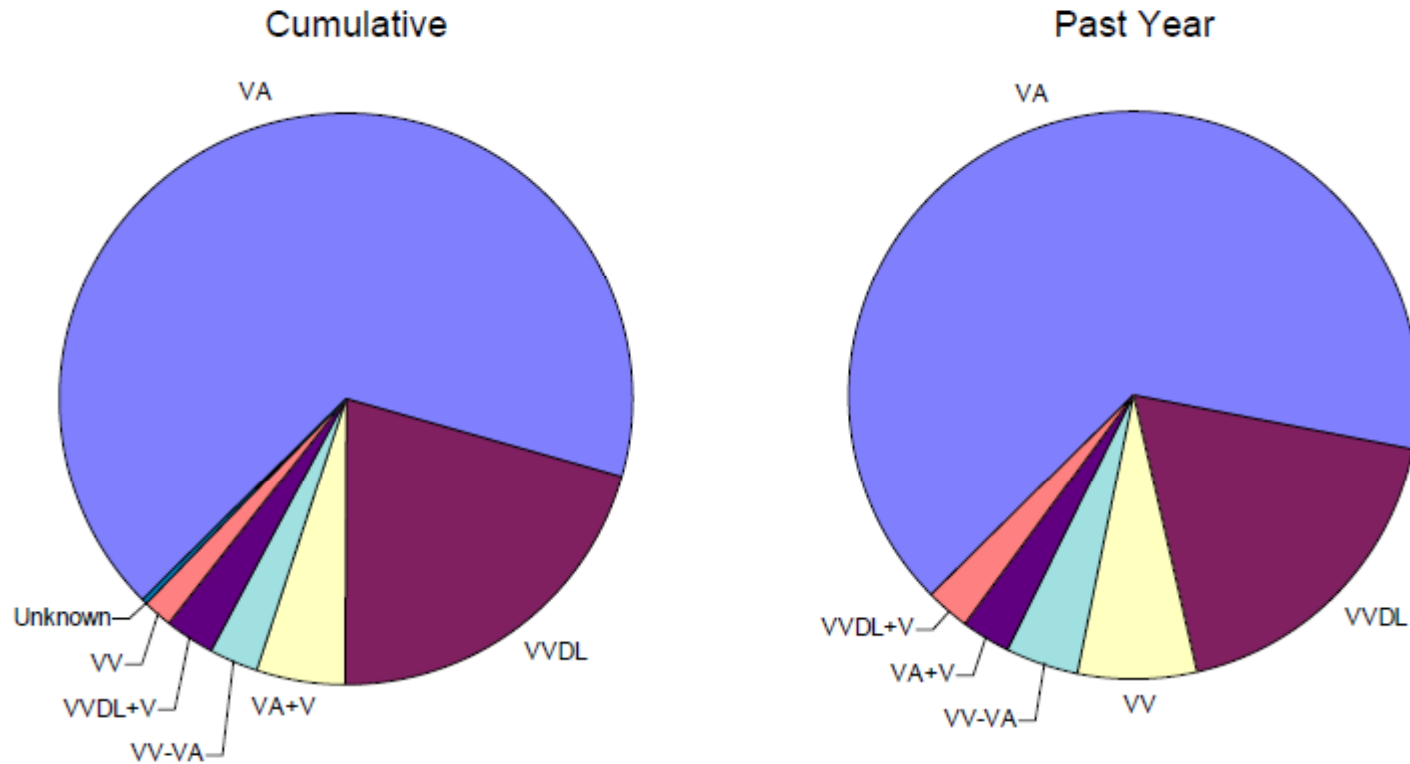
Diagnósticos

Neonatal Respiratory Runs by Diagnosis

	<i>Total Runs</i>	<i>Avg Run Time</i>	<i>Longest Run Time</i>	<i>Survived</i>	<i>% Survived</i>
CDH	7,228	254	2549	3,691	51%
MAS	8,684	133	1327	8,128	94%
PPHN/PFC	4,800	155	1176	3,696	77%
RDS	1,546	136	1093	1,300	84%
Sepsis	2,856	143	1200	2,084	73%
Pneumonia	376	249	1002	218	58%
Air Leak Syndrome	133	171	979	98	74%
Other	2,498	183	1843	1,519	61%

Run time in hours. Survived = survival to discharge or transfer based on number of runs

Neonatal Respiratory Support Mode



Neonatal Respiratory Support Mode Details

	<i>Total Runs</i>	<i>Avg Run Time</i>	<i>Longest Run Time</i>	<i>Survived</i>	<i>% Survived</i>
VA	18,781	181	2549	13,319	71%
VVDL	5,747	149	1429	4,850	84%
VA+V	1,402	182	1176	1,017	73%
VV-VA	823	244	1229	509	62%
VVDL+V	727	156	682	574	79%
VV	512	163	1227	381	74%
Unknown	66	181	1072	41	62%
VA-VV	35	276	956	24	69%
Other	28	235	956	19	68%

Neonatal Respiratory Complications

	<i>No. Reported</i>	<i>% Reported</i>	<i>No. Survived</i>	<i>% Survived</i>
Mechanical: Oxygenator failure	1,628	5.8%	864	53%
Mechanical: Raceway rupture	88	0.3%	50	57%
Mechanical: Other tubing rupture	162	0.6%	116	72%
Mechanical: Pump malfunction	469	1.7%	304	65%
Mechanical: Heat exchanger malfunction	205	0.7%	135	66%
Mechanical: Clots: oxygenator	4,753	16.9%	3,032	64%
Mechanical: Clots: bridge	2,534	9.0%	1,693	67%
Mechanical: Clots: bladder	4,015	14.3%	2,699	67%
Mechanical: Clots: hemofilter	862	3.1%	383	44%
Mechanical: Clots: other	2,234	7.9%	1,272	57%
Mechanical: Air in circuit	1,322	4.7%	907	69%
Mechanical: Cracks in pigtail connectors	701	2.5%	486	69%
Mechanical: Cannula problems	3,234	11.5%	2,136	66%
Hemorrhagic: GI hemorrhage	463	1.6%	202	44%
Hemorrhagic: Cannulation site bleeding	2,126	7.6%	1,361	64%
Hemorrhagic: Surgical site bleeding	1,764	6.3%	754	43%
Hemorrhagic: Hemolysis (hgb > 50 mg/dl)	3,006	10.7%	1,901	63%
Hemorrhagic: Disseminated intravascular coagulation (DIC)	801	2.8%	310	39%
Neurologic: Brain death clinically determined	243	0.9%	0	0%
Neurologic: Seizures: clinically determined	2,518	9.0%	1,525	61%
Neurologic: Seizures: EEG determined	336	1.2%	165	49%
Neurologic: CNS infarction by US/CT	1,974	7.0%	1,057	54%
Neurologic: CNS hemorrhage by US/CT	2,070	7.4%	900	43%
Renal: Creatinine 1.5 - 3.0	1,868	6.6%	947	51%
Renal: Creatinine > 3.0	368	1.3%	138	38%
Renal: Dialysis required	899	3.2%	353	39%
Renal: Hemofiltration required	4,348	15.5%	2,317	53%
Renal: CAVHD required	566	2.0%	246	43%
Cardiovascular: Inotropes on ECLS	6,167	21.9%	3,720	60%

Seguimiento

Escasos datos en insuficiencia respiratoria infantil
50% de los niños sobrevivientes al soporte cardíaco
tienen resultados del desarrollo neurológico anormal.

Impacto de la enfermedad subyacente y factores pre-ECLS.

Las anomalías del desarrollo pueden mejorar con el tiempo.

Escaso seguimiento estandarizado en la mayoría de los centros pediátricos grandes.

Hervey-Jumper SL, y col. Neurological complications of extracorporeal membrane oxygenation in children. J Neurosurg Pediatr 2011;7:338-44.

Adolph V, y col. Developmental outcome of neonates treated with extracorporeal membrane oxygenation. J Pediatr Surg 1990;25:43-6.

Hofkosh D, y col. Ten years of extracorporeal membrane oxygenation: neurodevelopmental outcome. Pediatrics 1991 ;87:549-55.

Raymond TI, y col. Outcomes among neonates, infants, and children after extracorporeal cardiopulmonary resuscitation for refractory in-hospital pediatric cardiac arrest: a report from the National Registry of Cardiopulmonary Resuscitation. Pediatr Crit Care Med 2010; 11 :362-71.

UK collaborative randomised trial of neonatal extracorporeal membrane oxygenation: follow-up to age 4 years

Dr Charlotte C Bennett, y col del UK Collaborative ECMO Trial Group
The Lancet: Volume 357, No. 9262, 7 April 2001

	ECMO (n=93)	Conventional care (n=92)
Deaths	31 (33%)	54 (59%)
Lost to follow-up or unable to allocate overall outcome	2 (2%)	3 (3%)
Severe disability	3 (3%)	0
Moderate disability	9 (10%)	10 (11%)
Mild disability	18 (19%)	12 (13%)
Impairment only	18 (19%)	9 (10%)
No abnormal signs or disability	12 (13%)	4 (4%)
Known survivors with no disability	30/60 (50%)	13/35 (37%)

ECMO=extracorporeal membrane oxygenation.

Resultados de ECPR

National Registry of Cardiopulmonary Resuscitation.

Raymond TT, American Heart Association National Registry of CPR Investigators.

RESULTADOS: 6288 RCP

- 199 (3.2%) ECPR
- 87 (43.7%) sobrevivientes al alta
- 59 con evaluación neurológica completa
- 56 (94.9%) con resultado favorable

Factores de riesgo:

- IRA previa al shock
- Anormalidades metabólicas o de electrolitos
- Uso de bicarbonato de sodio/trometamina

Factor protector: Enfermedad cardíaca. (causa del paro)

CONCLUSIONES: ECPR debe considerarse para pacientes internados con PCR refractario a medidas de reanimación convencionales.

Pediatr Crit Care Med. 2010 May;11(3):362-71

Seguimiento a 2 años

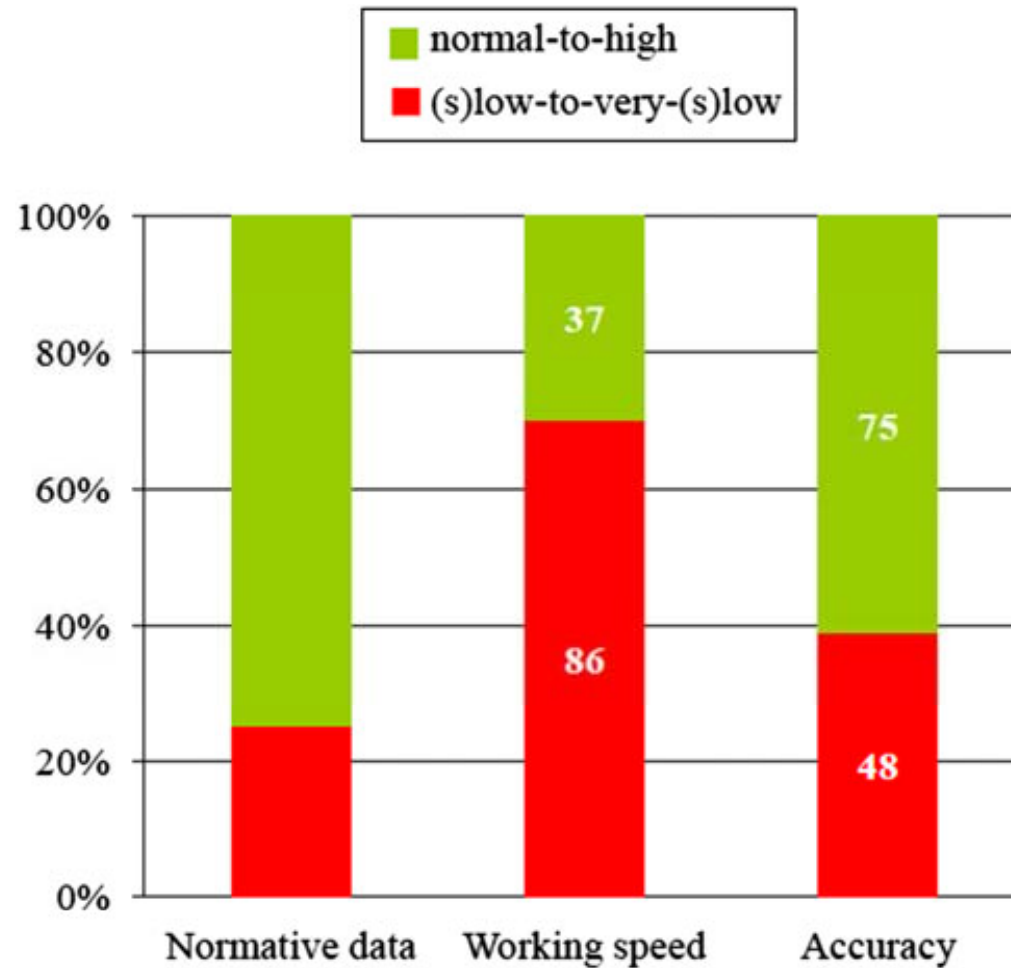
Eur J Cardiothorac Surg. 2000 Sep;18(3):328-33.

Two years' follow-up of newborn infants after extracorporeal membrane oxygenation (ECMO).

Jaillard S, Pierrat V, Truffert P, Métois D, Riou Y, Wurtz A, Lequien P, Storme L.

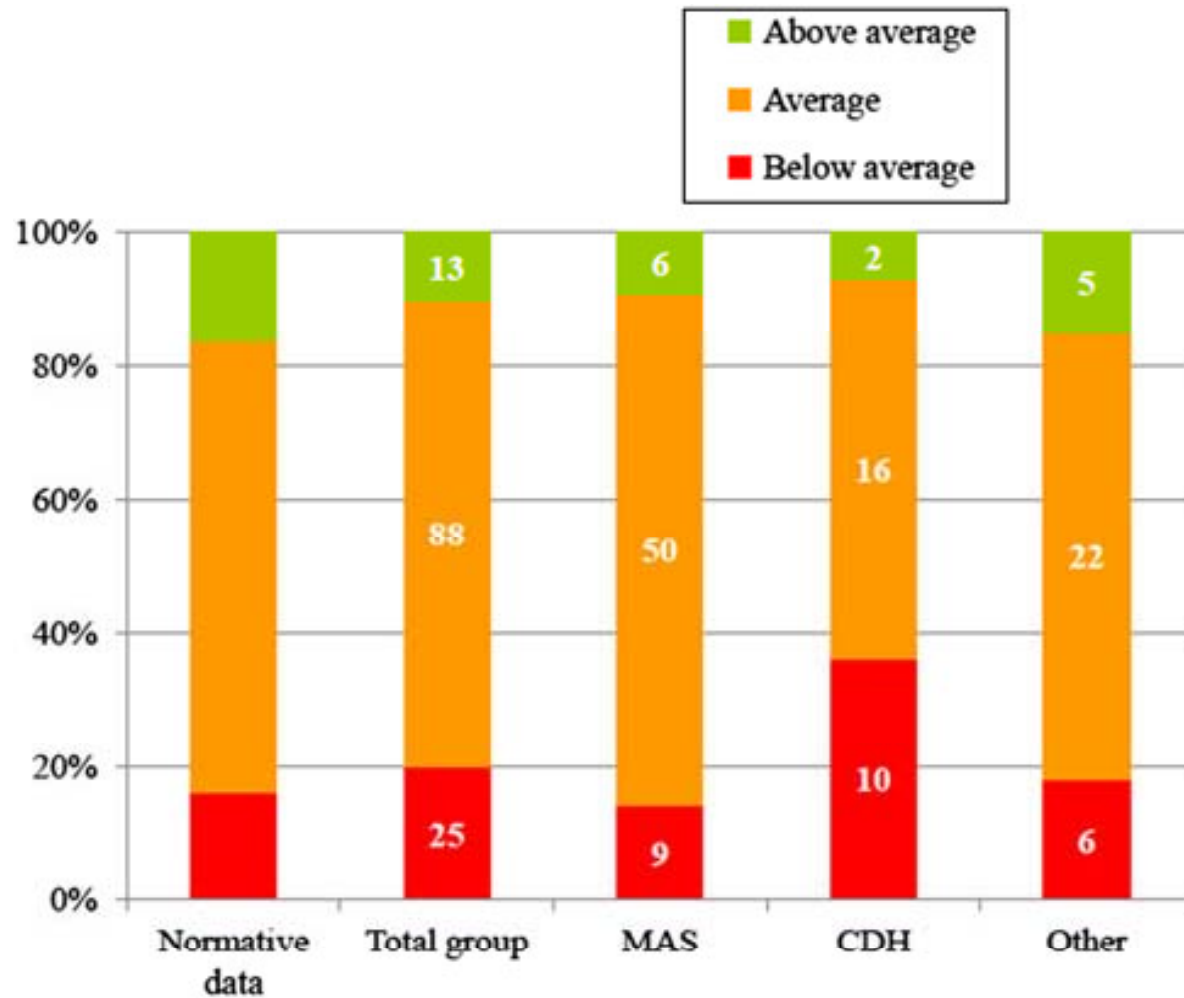
ECMO incrementó la sobrevida de RN con hipoxemia refractaria. Mayor sobrevida y menor morbilidad en no HDC.

Resultados del neurodesarrollo a los 8 años



Marlous J. Madderom y col, Intensive Care Med (2013) 39:1584–1593

Resultados del neurodesarrollo a los 8 años



Marlous J. Madderom y col, Intensive Care Med (2013) 39:1584–1593

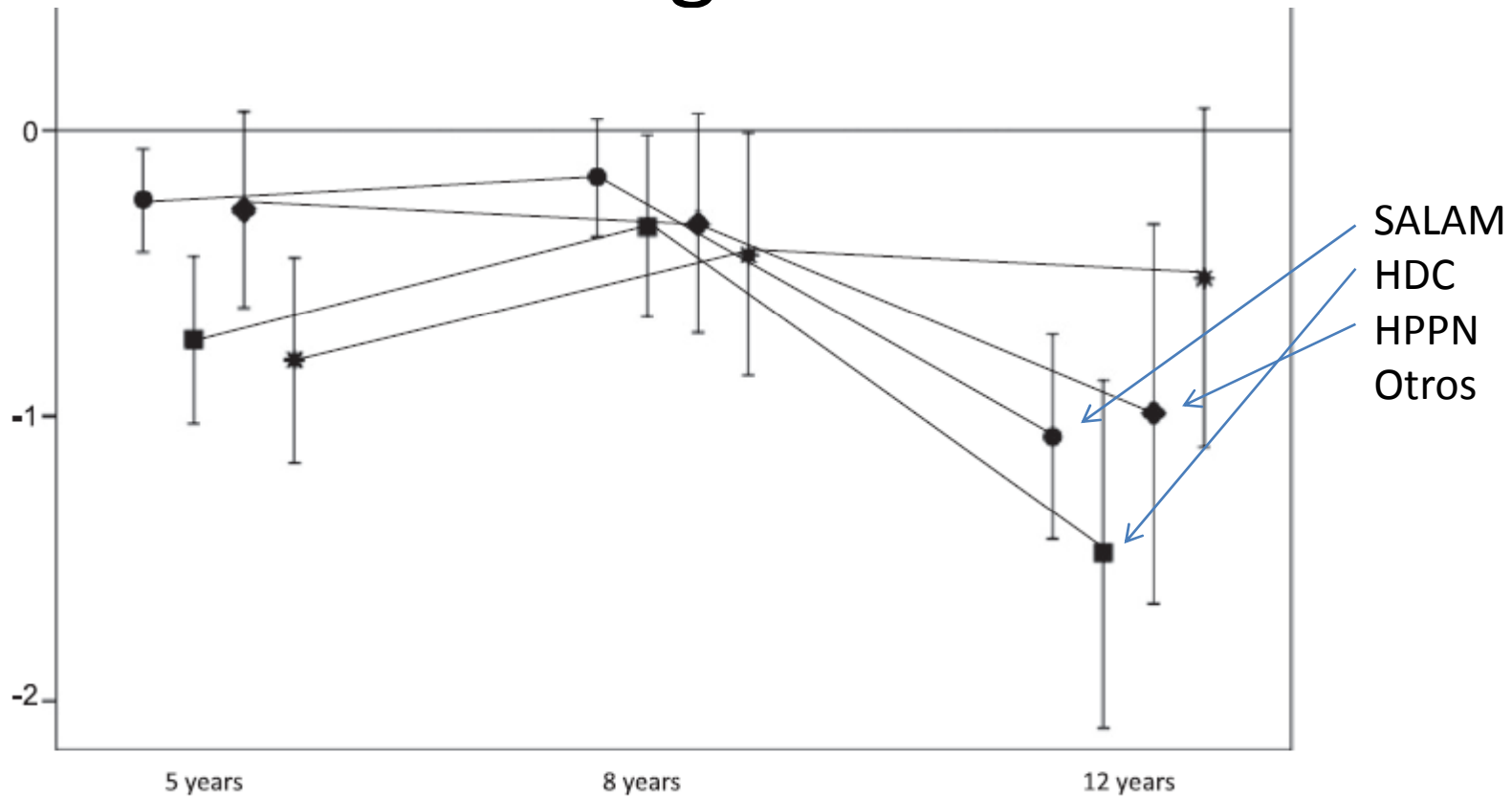
Resultados del neurodesarrollo a los 8 años

Conclusiones:

- Rango normal de inteligencia
- Problemas en concentración y comportamiento
- Seguimiento focalizado en detección precoz de deficit de aprendizaje.
- Diferencias según etiologías

Marlous J. Madderom y col, On behalf of the Dutch ECMO follow-up team.
Intensive Care Med (2013) 39:1584–1593

Motor Performance After Neonatal ECMO A Longitudinal Evaluation



Monique H.M. van der Cammen-van Zijp, PhD y col. on behalf of the Dutch ECMO follow-up team *Pediatrics* 2014;134

HDC y neurodesarollo

Neurodevelopmental outcome at one year of age in congenital diaphragmatic hernia infants not treated with ECMO

At one year of age, a high percentage of CDH children whose illness did not necessitate ECMO have below normal ND scores. Modifiable and non-modifiable factors are significant determinants of adverse outcomes.

Danzer E, Gerdes M, D'Agostino JA, J Pediatr Surg. 2015 Jun;50(6):898-903.

Calculador de riesgo

<https://www.else.org/Resources/ECMOOutcomePredictionScores.aspx>



Extracorporeal Life Support Organization

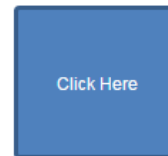
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ECMO Outcome Prediction Scores for estimating survival on ECMO

RESP-score



For adult patients on ECMO
for **respiratory failure**

These scores were developed as collaborative research by ELSO, The Australian & New Zealand Intensive Care Research Centre and The Alfred Hospital in Melbourne, Australia. This research was funded through the ELSO Research Program. These calculators are recommended for use by clinicians and researchers but are not recommended to be used for determining individual patient management while on ECMO or patient selection for ECMO. ELSO takes no responsibility for accuracy or application of calculations generated or for the use of these values.



¡Muchas Gracias!

