



# “Cold is Brain” Gestione dell’Ipotermia Accidentale Grave

4° Corso Nazionale di Medicina d’Emergenza ad alto  
rischio in ambiente alpino ed ipogeo-CNSAS

Gran Sasso d’Italia 25-29 ottobre 2010



# *Ipotermia*

***Abbassamento della Temperatura Centrale  
(CORE) al di sotto dei 35 ° c***

- **Lieve : 35°-32° c**
- **Moderata : 32°-28°c**
- **Severa < 28 ° c**



# *Ipotermia* : alterazioni fisiopatologiche

- ***SNC*** : Depressione del Sensorio fino al Coma (*shivering*)
- ***Respiratorio*** : Tachipnea, attivazione ortosimpatica, bradipnea. Ipossiemia Relativa (ALI / ARDS)
- ***Cardiocircolatorio*** : Tachicardia, bradicardia (Q-T lungo), TV-FV, Torsione di Punta poco responsiva a DC\_shock e farmaci; spesso Indotta da **AFTERDROP**
- ***Renale*** Inizialmente incremento, quindi ↓ output urinario
- ***Metabolico*** : Iperkaliemia da Rabdomiolisi
- ***Coagulazione*** : Inibizione del fattore VIIa
- ***Immunitario*** : Depressione funzione Neutrofili



# *Ipotermia.. Quando ?*

- *Seppellimento in Valanga*
- *Sommersione in Acqua Fredda*
- *Homeless Syndrome*
- *Disturbi Metabolici ed Endocrini*
- *Intossicazioni*
- *Neoplasie*
- *Trauma Grave*



**Clear consciousness  
with shivering**

**Core  
temperature  
°C:**

**35 – 32**

**HT  
II  
Impaired consciousness  
without shivering**

**32 – 28**

**HT  
III  
Unconsciousness  
with pulse**

**28 – 24**

**HT  
IV  
Apparent death  
pulsless**

**24 - 15**

**HT  
V  
Death due to  
irreversible Hypothermia**

**< 15 ?  
( < 9 ? )**



# Challenge Preospedaliero

- **Riconoscimento Ipotermia**
- **Misurazione della Temperatura & Triage VIVO-MORTO**
- **Decisione relativa ai Provvedimenti Terapeutici da Applicare sulla Scena**
- **Rischio di Aritimie Maligne (Afterdrop)**



## AFTERDROP

*Centralizzazione di sangue freddo e contenente metaboliti tossici (Lattato, Potassio) dalla periferia con conseguente ulteriore abbassamento della temperatura, effetti miocardiotoxici e possibili Aritmie Ventricolari maligne. Spesso indotto da movimentazione brusca durante le manovre di soccorso o di nursing ("Rescue Death")*

# Fattori che Peggiorano Controllo Termico in Montagna

- Ipossia Ipobarica
- Lattacidemia
- Basse Temperature
- Scarsa Alimentazione
- Scarsa Idratazione (Congelamenti)
- Patologie Pregresse-Utilizzo Farmaci Vasoattivi.
- Traumi Concomitanti







# NWS Windchill Chart



Temperature (°F)

Wind (mph)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63	
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72	
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77	
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81	
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84	
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87	
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89	
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91	
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93	
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95	
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97	
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98	

Frostbite Times

30 minutes

10 minutes

5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01



**Ipotermia Stadio IV-V**

**Dead or Alive?**





ON-SITE TRIAGE:	Exclude lethal injuries!	
	HT IV:	HT V:
Clinical findings:	No vital signs Chest: compressible Abdominal muscles: Kneadable	No vital signs <u>Not compressible</u> Not kneadable
ECG:	Ventricular fibrillation Asystole	<u>Asystole</u>
Coretemperature:	Above 15° Celsius (?)	<u>Below 15°Celsius (?)</u>
Potassium: (in the nearest hospital)	Below 12 mmol /l	<u>Above 12 mmol/l</u>

Serum potassium can be used as a criterion for triage only, if hypothermia is combined with asphyxia e.g. avalanche, immersion (cave: hemolysis, rhabdomyolysis). The on-site determination of the serum potassium is in evaluation at present.

Recently some clinical centres have begun to offer rewarming by cardiopulmonary bypass (CPB) without full heparinization of the patient. Consequently, rescue doctors have to decide whether there is a HT IV with additional injuries or a dead patient with lethal injuries and subsequent cooling down.

**Dead or Alive ?**  
**CISA\_IKAR**



# Peculiarità in Valanga

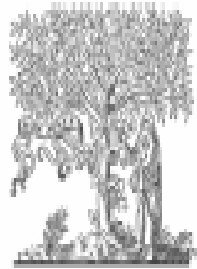
- *Durata del Seppellimento*
- *Politraumatismo ?*
- *Presenza Air Pocket ?*
- *Ritmo Cardiaco ?*
- *Kaliemia ?*







Resuscitation xxx (2010) xxx–xxx

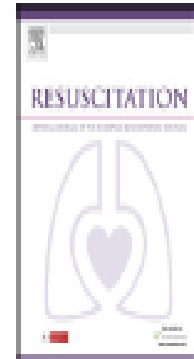


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# Resuscitation

journal homepage: [www.elsevier.com/locate/resuscitation](http://www.elsevier.com/locate/resuscitation)



## Review

# Prognostic factors in avalanche resuscitation: A systematic review<sup>☆</sup>

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<sup>d</sup> Innsbruck Medical University, Innsbruck, Austria



**Valle Sambuzza**  
**29 dicembre 2002**



# VAL SAMBUZZA 29.12.2002

**ORE 13.22** Il C. O. C.N.S.A.S. di Clusone riceve allarme da colonnina di soccorso del Passo del Publino

**ORE 13.25** Il C.N.S.A.S. allerta la COEU

**ORE 13.35** Intervento ELI per prima valutazione e ricerca..... negativa

**ORE 18.00** Segnalati alla COEU i nominativi di 3 persone "non rientrate"

## 30.12.2002

**ORE 08.00** Inizia attività sul posto per ELI

**ORE 09.00** Un utente chiama la COEU riferendo che autonomamente sta cercando gli amici dispersi sul versante nord della cima di Lemma.

Ha captato un segnale ARVA

**ORE 09.05** Constatazione di decesso per 2 persone: mancanza sacca d'aria.  
Contemporaneamente chiamata da zona ricerca in val Sambuzza

per il ritrovamento di sepolto con evidente sacca d'aria



**ORE 9.14** Si valuta la temperatura esofagea:  $+4.2^{\circ}\text{C}$ , presenza di rigidità diffusa che impedisce qualsiasi manovra (MCE o IOT), si decide per il trasporto a valle con verricello

**ORE 9.45** Si riceve richiesta dalla CCH di BG di ospedalizzare il III disseppellito

**ORE 9.57** Ingresso con l'ipotermico nel quartiere operatorio della CCH (mantenuto ulteriormente freddo durante il volo)

**Riferito di un primo controllo del K ematico =  $18\text{mEq/l}$ , riscaldamento fino a  $32^{\circ}\text{C}$ , evidente danno cellulare e tissutale.EXITUS**





## Research letters

### Resuscitation from accidental hypothermia of 13.7°C with circulatory arrest

*Mads Gilbert, Rolf Busund, Arne Skagseth, Paul Åge Nilsen, Jan P Solbø*

**In a victim of very deep accidental hypothermia, 9 h of resuscitation and stabilisation led to good physical and mental recovery. This potential outcome should be borne in mind for all such victims.**

and winched her into the helicopter. CPR and positive-pressure manual ventilation bag-to-tube was continued during the 1 h flight to Tromsø University Hospital. They arrived at 2110 h.





# Il Caso (1)

- Sommersione in Acqua Fredda
- Nessuna Comorbidità
- No Trauma Associato
- Pronta RCP
- Elisoccorso
- Corretto Indirizzo Ospedaliero



# Il Caso (2)

- By Pass Cardiopolmonare in DEA
- ROSC (Return-of-Spontaneous-Circulation) : **T esofagea 25 ° c**
- Prolungata degenza ICU, complicata (ARDS, DIC, MOSF)
- **Completo Recupero Neurologico !**



# Ipotermia 13.7°C

<b>Hypothermia 13.7</b>	<b>Arrivo</b>	<b>5' CPB</b>	<b>ROSC</b>	<b>Fine CPB</b>
<b>PH</b>	<b>6.65</b>	<b>6.54</b>	<b>6.64</b>	<b>7.14</b>
<b>Hb</b>	<b>15.7</b>	<b>13.1</b>	<b>12.2</b>	<b>7.4</b>
<b>BE</b>	<b>-27</b>	<b>-27</b>	<b>-27</b>	<b>-15</b>
<b>T° Esof.</b>	<b>14.4</b>	<b>18.2</b>	<b>25.0</b>	<b>37.6</b>
<b>K+</b>	<b>4.3</b>	<b>8.2</b>	<b>6.7</b>	<b>4.2</b>



Eur J Cardio-thorac Surg (1990) 4: 390–393

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European Journal of  
**Cardiothoracic  
Surgery**  
© Springer-Verlag 1990

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## **Accidental deep hypothermia with cardiopulmonary arrest: extracorporeal blood rewarming in 11 patients**

**B. H. Walpoth, T. Locher, F. Leupi, P. Schüpbach, W. Mühlemann, and U. Althaus**

Department of Thoracic and Cardiovascular Surgery, University of Berne, Inselspital, Berne, Switzerland



**Table 1.** Patients

	Sex	Age (years)	Type of accident	Concomitant injury
Survivors <i>n</i> = 7	3 M 4 F	24.1 (13 - 42)	4 crevasses (+ 1 avalanche) 3 exposures (2 suicides) + intoxic.)	2 pneumo- thorax 1 aspiration 2 regional frostbites
Non survivors <i>n</i> = 4	3 M 1 F	35.0 (21 - 53) (21 - 53)	1 avalanche 1 drowning 1 crevasse 1 exposure (water/suicide)	1 asphyxia 1 asphyxia 1 head injury 1 aspiration

**Table 2.** Time course

	Time of cold exposure (h)	Total transportation time (h)	Time elapsed at 1st hospital (h)	Time of circulatory arrest (h)
Survivors <i>n</i> = 7	4.4 (2.0 - 5.5)	2.0 (0.9 - 3.0)	1.5 (1.0 - 2.5) <i>n</i> = 5	2.5 (1.4 - 3.7)
Non survivors <i>n</i> = 4	4.7 (4.0 - 5.5)	1.5 (0.7 - 2.2)	(1.6) <i>n</i> = 1	1.1 (0.2 - 2.0) <i>n</i> = 2

**Table 3.** Temperatures (°C)

	At first hospital	On admission	Before CPB	After CPB	At ICU arrival
Survivors <i>n</i> = 7	22.1 (18.2 - 27) <i>n</i> = 5	22.0 (17.5 - 26)	22.2 (18 - 26)	34.1 (33 - 36)	33.1 (31.6 - 33.7)
Non survivors <i>n</i> = 4	(24) <i>n</i> = 1	23.0 (20 - 25)	24.0 (23 - 25)	34.2 (32 - 36)	(35.6) <i>n</i> = 1



	Crevasse	Exposure	Avalanche & Drowning	Total
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Recovery	4	3	0	7
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Death	1	0	3	4
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The New England Journal of Medicine

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OUTCOME OF SURVIVORS OF ACCIDENTAL DEEP HYPOTHERMIA AND  
CIRCULATORY ARREST TREATED WITH EXTRACORPOREAL BLOOD WARMING

BEAT H. WALPOTH, M.D., BEYHAN N. WALPOTH-ASLAN, M.D., HEINRICH P. MATTLE, M.D., BOGDAN P. RADANOV, M.D.,  
GERHARD SCHROTH, M.D., LEONARD SCHAEFFLER, M.D., ADAM P. FISCHER, M.D., LUDWIG VON SEGESSER, M.D.,  
AND ULRICH ALTHAUS, M.D.



TABLE 1. CHARACTERISTICS OF THE PATIENTS AT REWARMING AND FOLLOW-UP.\*

PATIENT No.	SEX/ AGE (YR)	CAUSE OF HYPOTHERMIA	ADDITIONAL INJURIES	CORE TEMPERATURE BEFORE REWARMING (°C)	NEUROLOGIC FINDINGS†		
					CNS	PNS	OVERALL
1	F/24	Fall into crevasse and ice water	Injury of left brachial plexus during rescue	24.0 (E)	Normal	Mild lesion of left-arm plexus with extension deficit of fingers due to injury during rescue	Borderline
2	F/25	Exposure while hiking	—	24.4 (E)	Normal	Normal	Normal
3	F/43	Avalanche	Shoulder fracture	19.6 (R)	Normal	Normal	Normal
4	F/31	Exposure after suicide attempt‡	—	25.0 (R)	Normal	Normal	Normal
5	M/42	Fall into crevasse and ice water	Femur fracture	20.0 (E)	Normal	Normal	Normal
6	M/9	Fall into crevasse and ice water	—	21.0 (E)	Mild abnormalities of coordination and fine finger movements	Normal	Borderline
7	M/25	Fall into crevasse	Frostbite	17.5 (E)	Mild abnormality of coordination of left hand, mild ataxia during tandem walking	Normal	Borderline
8	F/22	Exposure after suicide attempt‡	—	22.0 (E)	Normal	Normal	Normal
9	M/28	Fall into crevasse	—	22.1 (E)	Dysesthesia of left foot, reflex asymmetry, no motor impairment	Normal	Borderline
10	M/13	Exposure after attempted murder	Brain injury, bilateral anterior tibial compartment syndromes	24.0 (R)	Borderline (mild athetosis)	Bilateral foot drop and step-gait after anterior tibial compartment syndromes	Pathologic
11	M/17	Exposure after suicide attempt‡	Rib fractures	20.0 (R)	Normal	Normal	Normal
12	M/13	Fall into crevasse	Injury of left brachial plexus during rescue	17.1 (E)	Normal	Mild lesion of left-arm plexus with extension deficit of fingers due to injury during rescue	Borderline
13	F/26	Exposure after suicide attempt‡	—	23.0 (R)	Normal	Normal	Normal
14	M/25	Prolonged immersion in cold water after boating accident	—	24.5 (R)	Preexisting hemicord syndrome on the right (no worsening after hypothermia)	Normal	Pathologic
15	F/35	Exposure after suicide attempt‡	—	23.5 (R)	Normal	Normal	Normal



## Annals of Thoracic Surgery

### "Cardiopulmonary bypass resuscitation for accidental hypothermia"

Vretenar & Coll

**CANADA 1994 esperienza multicentrica:**

- Analizzati i dati di **68** pazienti ipotermici "resuscitati" in CEC
- Temperatura interna media al momento del ritrovamento **21 C°**
  - **90%** erano in arresto cardiaco
- La CEC è stata applicata per via femoro-femorale nel 72% dei casi
  - Sopravvivenza complessiva: **60%**
- Nessun sopravvissuto tra i 6 pazienti con temperatura < **15 C°**
- Mortalità più elevata nei pazienti in arresto cardiaco, vittime di valanghe o scalatori

### **CONCLUSIONI:**

- Riscaldamento in CEC metodo di 1° scelta nei pazienti in arresto cardiaco o con temperatura < 25 C°



## BERGEN - NORVEGIA 1987 - 2000

- 26** casi di ipotermia accidentale riscaldati in CEC
- Età media **26,7** (anni range 1,9 - 76 anni )
- Immersione in acqua fredda (17), slavina (1), ambiente freddo (8)
- 22** in arresto cardiorespiratorio, **4** in arresto respiratorio
- Mortalità complessiva 18 casi (**69%**)
- Causa del decesso: 7 in CEC, 1 per aritmia, 5 per sofferenza cerebrale  
1 per emorragia cerebrale, 4 per insufficienza cardiorespiratoria
- Pazienti rinvenuti asfittici : **deceduti 14/15**
- Pazienti rinvenuti non asfittici: **deceduti 4/11**



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Resuscitation 59 (2003) 285–290

RESUSCITATION



[www.elsevier.com/locate/resuscitation](http://www.elsevier.com/locate/resuscitation)

# Outcome from severe accidental hypothermia in Southern Finland— a 10-year review

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Received 31 March 2003; received in revised form 1 May 2003; accepted 12 June 2003



# Helsinki, 2003

- Review pazienti Ipotermici Trattati periodo 1993-2003
- Endpoint Primario : identificare fattori associati alla sopravvivenza di pazienti ipotermici Stadio IV riscaldati in ECC
- 23 pazienti in ACC Ipotermico posti in ECC
- Sopravvivenza 61 %
- Fattori associati alla Sopravvivenza : Età ( $P=0.15$ ) ,PH Arterioso ( $P=0.011$ ), PaCO<sub>2</sub> ( $P=0.003$ ) , Kaliemia ( $P=0.007$ )



I pazienti in Ipotermia  
Accidentale Profonda Stadio IV  
devono essere sottoposti ad RCP  
e trasferiti in un Centro dotato di  
CCh per essere sottoposti a ECC  
femoro-femorale o  
sternotomica.



La Sopravvivenza e l'Outcome di questi pazienti dipendono principalmente dalla causa che ha provocato l'Ipotermia e dalla eventuale presenza di cofattori (Asfissia, Ipovolemia, Acidosi)





*Regione Lombardia – A.O. Ospedali Riuniti di Bergamo*

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**DIPARTIMENTO DI EMERGENZA E URGENZA DI ALTA SPECIALITA'**

*Direttore: Dott. Valter Sonzogni*

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**DIPARTIMENTO DI ANESTESIA E RIANIMAZIONE**

*Direttore Prof. Roberto Fumagalli*

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**DIPARTIMENTO DI CHIRURGIA CARDIOVASCOLARE**

*Direttore Dott. Paolo Ferrazzi*

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**U.S.S.D. Servizio Sanitario Urgenza Emergenza "118"**

*Responsabile: Dott. Oliviero Valoti*

---

**Elisoccorso Medico Regionale – Polo di Bergamo**

*Referente: Dott. Angelo Giupponi*

**Protocollo di trattamento e gestione del Paziente  
ipotermico accidentale grave sul territorio e  
presso strutture specialistiche**



# ARRESTO CARDIACO IPOTERMICO

## ESPERIENZA DI BERGAMO

Data	Cognome	Nome	Età	Sex	Luogo	Hvalanga	Hritrov	Temp	Hosped	HCEC	Primo K+	Primo pH	Primo BE	Fine CEC	Esito	Anest	Chirurgo
18/12/2004	Tinelli	Carla	57	F	Adda		14.00	21	15.10	15.58	5,2	7,16	-16	17.09	V	Ferri	Gamba
17/12/2005	Quistini	Franco	58	M		14.10		22		17.10	10,8	6,72	-28,4	19,15	M	Cossolini	Gamba
26/02/2006	Arrigo	Paolo	40	M	Livigno	11.45	13.00	16	M	15.10	10,5	6,55	-31	17.50	M	Ferri	Triggiani
14/12/2008	Roveda	Fabrizio	64	M	Grigna	15.00	15.05	21	15.40	16.46	2,6	7,17	-10,8	18.07	V	Ferri	Giordano
07/02/2010	Broggi	Rita	49	F	M.Corona		15.20	13,5	16.20	16.48	6,7	6,51	-30,8	20.20	M	Vavassori	Giordano
19/02/2010	Pennacchio	Sergio	24	M	Colere	15.00	17.00	22	20.45	21.10	10,7	6,69	-25,3	23,15	M	Vavassori	Terzi
22/02/2010	Borgonovo	Emilio	71	M	Bormio	11.00	11.40	27	12,30	12.59	6,9	6,87	-22,5	14,25	D	Ferri	Terzi



## EVENTO - CEC

106	V
108	M
118	V
119	D
180	M
205	M
370	M



# Temperatura

13,5	M
16	M
21	V
21	V
22	M
22	M
27	D



# Primo K+

2,6	V
5,2	V
6,7	M
6,9	D
10,5	M
10,7	M
10,8	M



## Primo pH

6,51	M
6,55	M
6,69	M
6,72	M
6,87	D
7,16	V
7,17	V



# Primo BE

-31	M
-30,8	M
-28,4	M
-25,3	M
-22,5	D
-16	V
-10,8	V

## Prolonged extracorporeal membrane oxygenation-assisted support provides improved survival in hypothermic patients with cardiocirculatory arrest

Elfriede Ruttmann, MD,<sup>a</sup> Annemarie Weissenbacher, MD,<sup>a</sup> Hanno Ulmer, PhD,<sup>b</sup> Ludwig Müller, MD,<sup>a</sup> Daniel Höfer, MD,<sup>a</sup> Juliane Kilo, MD,<sup>a</sup> Walter Rabl, MD,<sup>c</sup> Birgit Schwarz, MD,<sup>d</sup> Günther Laufer, MD,<sup>a</sup> Herwig Antretter, MD,<sup>a</sup> and Peter Mair, MD<sup>d</sup>



Dr Ruttmann



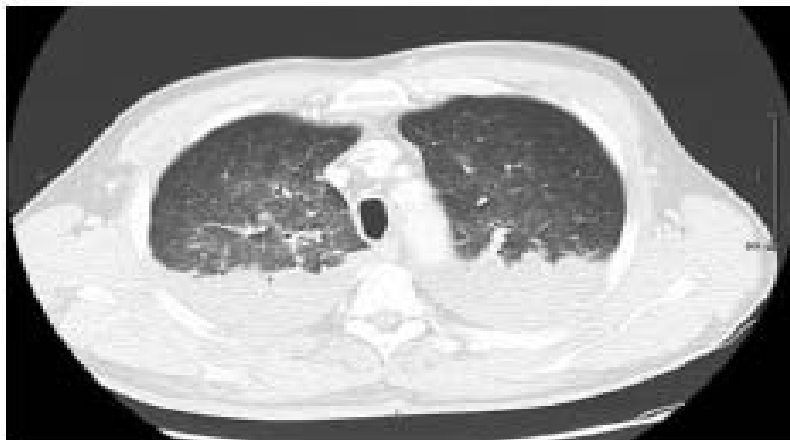
Dr Weissenbacher

**Objective:** Extracorporeal circulation is considered the gold standard in the treatment of hypothermic cardiocirculatory arrest; however, few centers use extracorporeal membrane oxygenation instead of standard extracorporeal circulation for this indication. The aim of this study was to evaluate whether extracorporeal membrane oxygenation-assisted resuscitation improves survival in patients with hypothermic cardiac arrest.

**Methods:** A consecutive series of 59 patients with accidental hypothermia in cardiocirculatory arrest between 1987 and 2006 were included. Thirty-four patients (57.6%) were resuscitated by standard extracorporeal circulation, and 25 patients (42.4%) were resuscitated by extracorporeal membrane oxygenation. Accidental hypothermia was caused by avalanche in 22 patients (37.3%), drowning in 22 patients (37.3%), exposure to cold in 8 patients (13.5%), and falling into a crevasse in 7 patients (11.9%). Multivariate logistic regression analysis was used to compare extracorporeal membrane oxygenation with extracorporeal circulation resuscitation, with adjustment for relevant parameters.

**Results:** Restoration of spontaneous circulation was achieved in 32 patients (54.2%). A total of 12 patients (20.3%) survived hypothermia. In the extracorporeal circulation group, 64% of the nonsurviving patients who underwent restoration of spontaneous circulation died of severe pulmonary edema, but none died in the extracorporeal membrane oxygenation group. In multivariate analysis, extracorporeal membrane





**Figure 1. Severe pulmonary edema in a person rescued from a crevasse after successful ECMO-assisted resuscitation. Prolonged ECMO assistance was necessary for 27 hours because of massive reperfusion edema of the lung. Computed tomographic scan was performed after the patient was normothermic. ECMO, extracorporeal membrane oxygenation.**

**TABLE 3. Causes of death in patients with restoration of spontaneous circulation (ROSC) (n = 21 patients)**

	<b>ECC group n = 14 patients</b>	<b>ECMO group n = 7 patients</b>
Pulmonary edema	9 (64.3%)	0 (0%)
Multiorgan failure	2 (14.3%)	3 (50%)
Brain death	2 (14.3%)	3 (42.9%)
Aortic dissection/retroperitoneal hematoma	0 (0%)	1 (16.7%)
Bleeding	1 (7.1%)	0 (16.7%)
Median time from ROSC to death (hours, range)	23 (0.5–110)	42 (18–216)

*ECC*, Extracorporeal circulation; *ECMO*, extracorporeal membrane oxygenation; *ROSC*, return of spontaneous circulation.

**TABLE 1. Overview of hypothermic patients who have been resuscitated by the use of extracorporeal techniques (n = 59 patients)**

	ECC group (1987–1996) n = 34 patients	ECMO group (1996–2006) n = 25 patients	P value
Age in years (mean, SD)	28 ± 16	36 ± 19	.068
Male gender (n, %)	28 (82.4%)	21 (84.0%)	.72
Cause of hypothermia-related cardiocirculatory arrest			
Avalanche	16 (47.1%)	6 (24.0%)	
Drowning	11 (32.4%)	11 (44.0%)	
Crevasse	3 (8.8%)	4 (16.0%)	
Exposure to cold	4 (11.8%)	4 (16.0%)	.34
Body core temperature at admission in degrees Celsius (mean, SD)	24.6 ± 2.9	24.2 ± 4.7	.66
Burial/Submersion Time in Minutes (mean, SD)	94 ± 85 min	92 ± 134 min	.94
Serum potassium at admission in mmol/L (mean, SD)	7.8 ± 4.4	6.9 ± 3.7	.45
pH at admission (mean, SD)	6.7 ± 0.27	6.7 ± 0.28	.64
Cardiac rhythm at admission			
Asystole	18 (52.9%)	13 (52.0%)	
Ventricular fibrillation	15 (44.1%)	10 (40.0%)	
Pulseless electrical activity	1 (2.9%)	2 (8.0%)	.68

ECC, Extracorporeal circulation; ECMO, extracorporeal membrane oxygenation; SD, standard deviation.

**TABLE 2. Univariate comparison of possible predictive parameters associated with survival of severe hypothermia associated with cardiocirculatory arrest**

	Nonsurvivors n = 47 patients	Survivors n = 12 patients	P value
Age in years (mean, SD)	29.5 ± 16.7	38.3 ± 20.1	.20
Male gender (n, %)	41 (87.2%)	9 (75.0%)	.37
Asphyxia-associated cause (Avalanche, Drowning) (n, %)	40 (85.1%)	4 (33.3%)	.001
ECMO-assisted resuscitation (n, %)	16 (34.0%)	9 (75.0%)	.02
Burial/submersion time in minutes (if avalanche or drowning)	94.7 ± 86	92.2 ± 134.6	.44
Body core temperature at admission (mean, SD)	24.5 ± 0.68	24.2 ± 0.35	.77
Asystole at admission (n, %)	27 (57.4%)	4 (33.3%)	.20
Lactate at admission (mean, SD)	136.9 ± 64.2	118.1 ± 59.0	.57
pH at admission (mean, SD)	6.64 ± 0.24	6.80 ± 0.32	.026
Potassium at admission (mean, SD)	8.1 ± 4.30	4.9 ± 1.90	.014
Activated clotting time in seconds (mean, SD)	201.7 ± 45.5	204.7 ± 32.0	.92

SD, Standard deviation; ECMO, extracorporeal membrane oxygenation.

**TABLE 4. Results of the multivariate logistic regression analysis to evaluate independent predictors for survival of accidental hypothermia with cardiocirculatory arrest (n = 59 patients)**

	Wald	Relative risk	95% confidence interval	P value
Asphyxia-related cause of hypothermia (avalanche, drowning)	6.2	0.09	0.01–0.60	.013
ECMO-assisted resuscitation	4.2	6.61	1.2–49.3	.042
Potassium at admission (per mmol/L)	2.8	0.62	0.36–1.1	.09
pH at admission	0.018	0.89	0.02–83.8	.89

ECMO, Extracorporeal membrane oxygenation.





*“Noi facciamo le Montagne  
che sappiamo fare, non quelle  
che vogliamo fare”*

*Casimiro Ferrarì*

**Falco... Dario, Marco, Fabrizio e Stefano**

**Grazie...**



la valanga  
umana



Grazie per la Vostra  
Attenzione