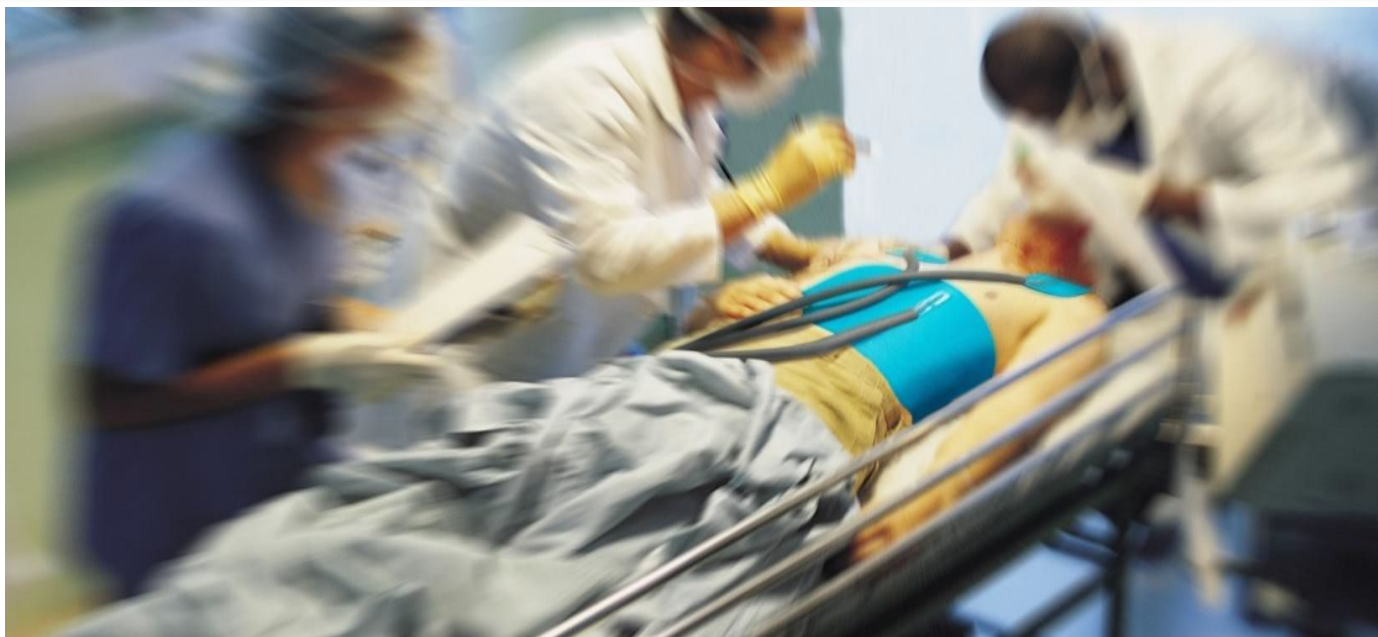


选择性头部低温在心肺脑复苏中的 研究应用进展



余 涛

中山大学心肺脑复苏研究所
中山大学孙逸仙纪念医院

内容提要

治疗性亚低温的简史

治疗性亚低温的作用机理

治疗性亚低温的临床实施

选择性头部低温研究进展

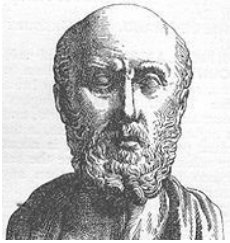
小 结



HISTORY

治疗性亚低温的简史

古代对于低温的认识



Hippocrates

希波克拉底：建议将受到严重创伤的病人用冰雪覆盖能够减少失血。



Tuo Hua

华佗：采用物理降温的方法治疗发热病人。

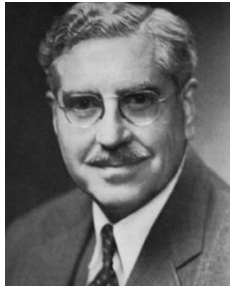


Baron Larrey

巴朗：发现雪地中靠近篝火的受伤士兵往往比受冻者更早死亡。

Larry IJ: Memories of military service and campaigns of French armies, vol 2. Baltimore, J Cushing, 1814, pp 156-164

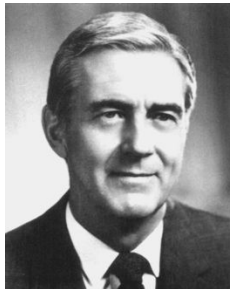
最早关于治疗性低温应用于临床的报道 (1945-1950年)



Fay T

采用亚低温治疗严重颅脑损伤病人，
改善生存及神经功能预后。

Fay T. Observations on refrigeration in cases of severe cerebral trauma. Res Publ Ass Nerv Ment Dis. 1945;24:611-19.



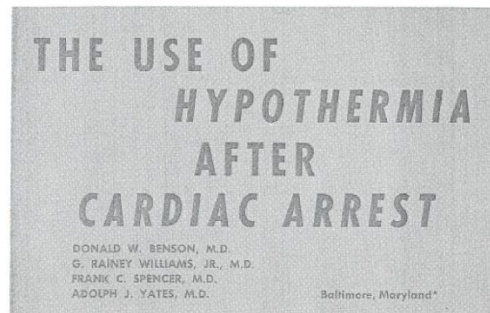
Bigelow WG

将低温技术引入心胸外科手术。

Bigelow WG. General hypothermia for experimental intracardiac surgery. Ann Surg. 1950;80:522-32.

VOLUME 38, NUMBER 6 — NOVEMBER-DECEMBER, 1959

423



1959年，马里兰州巴尔迪摩市首次报道亚低温能够改善心脏骤停后患者生存预后。

Benson DW, et al. The use of hypothermia after cardiac arrest. Anesthesia and Analgesia. 1959;38:423-28.

HEART-LUNG RESUSCITATION

I FIRST AID: OXYGENATE THE BRAIN IMMEDIATELY

IF UNCONSCIOUS

Airway - TILT HEAD BACK

IF NOT BREATHING

Breathe - INFLATE LUNGS 3-5 TIMES,
MAINTAIN HEAD TILT

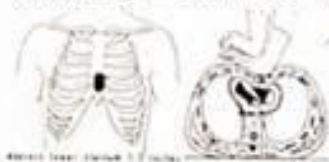
• FEEL PULSE

• IF PRESENT - CONTINUE LUNG INFLATIONS

• IF ABSENT -

Circulate - COMPRESS HEART ONCE A SECOND.

ALTERNATE 2-3 LUNG INFLATIONS WITH
15 STERNAL COMPRESSIONS UNTIL
SPONTANEOUS PULSE RETURNS.



II START SPONTANEOUS CIRCULATION

Drugs - EPINEPHRINE: 1.0 mg (10 CC OF 1:1000) I.V. OR 0.3 mg INTRACARDIAC
REPEAT LARGER DOSE IF NECESSARY.

SODIUM BICARBONATE: APPROXIMATELY 3.75 G/50 CC (1/2 DOSE IN CHILDREN) I.V.
REPEAT EVERY 5 MINUTES IF NECESSARY.

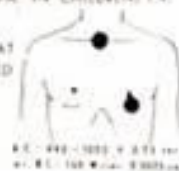
E. K. G. - • FIBRILLATION: EXTERNAL ELECTRIC DEFIBRILLATION REPEAT
SHOCK EVERY 1-3 MINUTES UNTIL FIBRILLATION REVERSED
• IF ASYSTOLE OR WEAK BEATS: EPINEPHRINE OR
CALCIUM I.V.

Fluids - I.V. PLASMA, DEXTRAN, SALINE

Do not interrupt cardiac compressions and ventilation.
Tracheal intubation only when necessary.

AFTER RETURN OF SPONTANEOUS CIRCULATION USE VASOPRESSORS AS NEEDED.

e.g. NOREPINEPHRINE (Levophed) I.V. DRIP



III SUPPORT RECOVERY

Gauge

EVALUATE AND TREAT CAUSE OF ARREST

Hypothermia

START WITHIN 30 MINUTES IF NO SIGN OF CNS RECOVERY

Intensive Care

SUPPORT VENTILATION: TRACHEOTOMY, PROLONGED CONTINUED
VENTILATION, GASTRIC TUBE IF NECESSARY

SUPPORT CIRCULATION

CONTROL CONVULSIONS

MONITOR

Figure 1. Heart-lung resuscitation (cardiopulmonary-cerebral resuscitation). First composition in 1961, Pittsburgh, PA. Reproduced with permission from Safar P. Community-wide CPR. J Iowa Medical Society 1964 (Nov); pp 629-635.



亚低温用于心肺复苏的现代发展



Peter Safar

心肺脑复苏的先驱，带领团队自20世纪80年代开始亚低温用于心肺复苏的动物和临床研究，为亚低温治疗用于心肺复苏临床奠定基础。

亚低温在心肺脑复苏中的保护作用的确立



Resuscitation 51 (2001) 275–281

Mild hypothermia induced by a helmet device: a clinical feasibility study



Said Hachimi-Idrissi *, Luc Corne, Guy Ebinger, Yvette Michotte, Luc Huyghens

*Department of Critical Care Medicine and Cerebral Resuscitation Research Group, AZ-VUB, Free University of Brussels, Laarbeeklaan, 101,
B-1090, Brussels, Belgium*

**Idrissi,
2001**

The New England Journal of Medicine

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VOLUME 346

FEBRUARY 21, 2002

NUMBER 8



MILD THERAPEUTIC HYPOTHERMIA TO IMPROVE THE NEUROLOGIC OUTCOME AFTER CARDIAC ARREST

THE HYPOTHERMIA AFTER CARDIAC ARREST STUDY GROUP*

TREATMENT OF COMATOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST WITH INDUCED HYPOTHERMIA

STEPHEN A. BERNARD, M.B., B.S., TIMOTHY W. GRAY, M.B., B.S., MICHAEL D. BUIST, M.B., B.S.,
BRUCE M. JONES, M.B., B.S., WILLIAM SILVESTER, M.B., B.S., GEOFF GUTTERIDGE, M.B., B.S., AND KAREN SMITH, B.Sc.

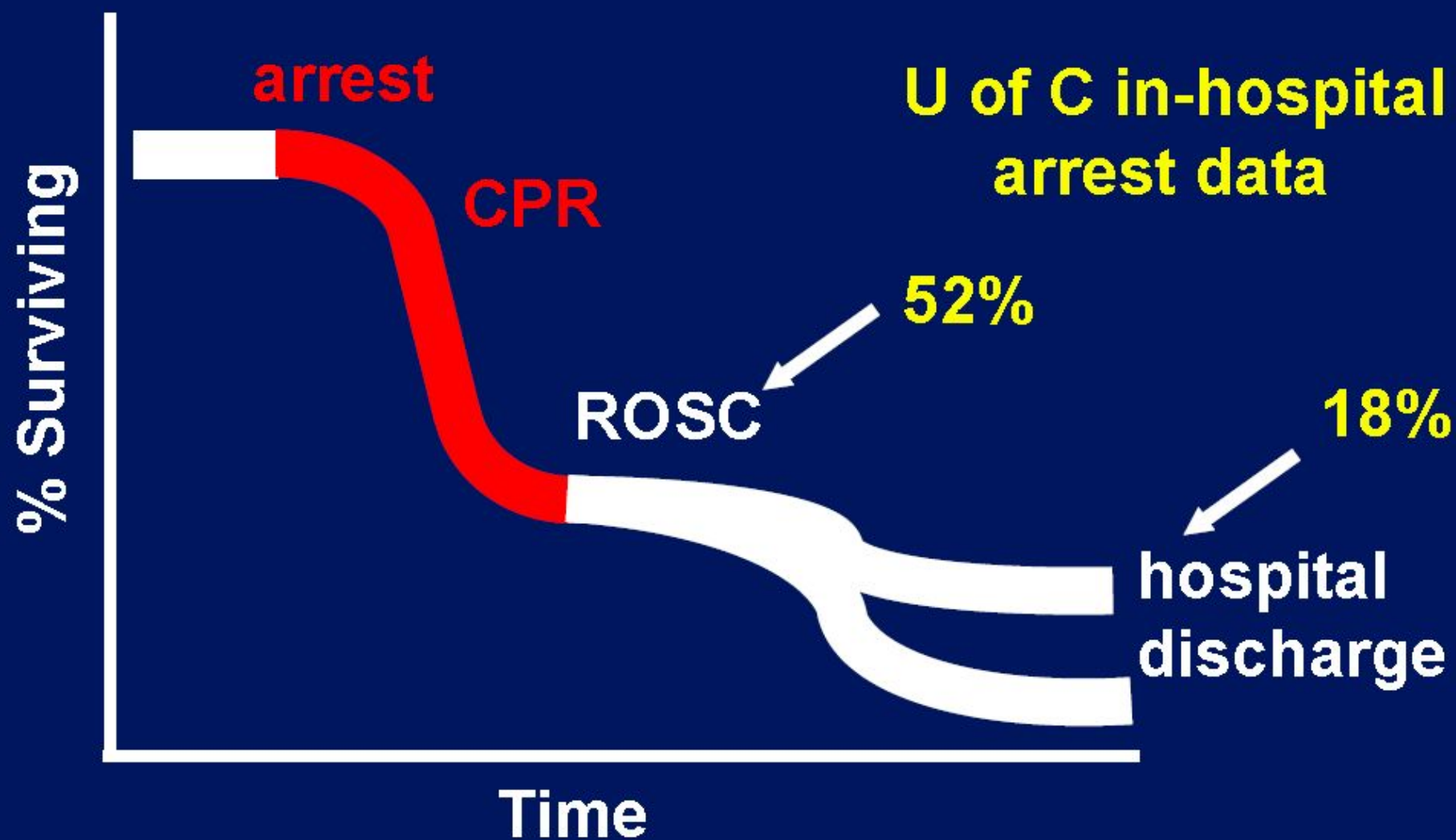
**HACA,
2002**

**Bernard,
2002**

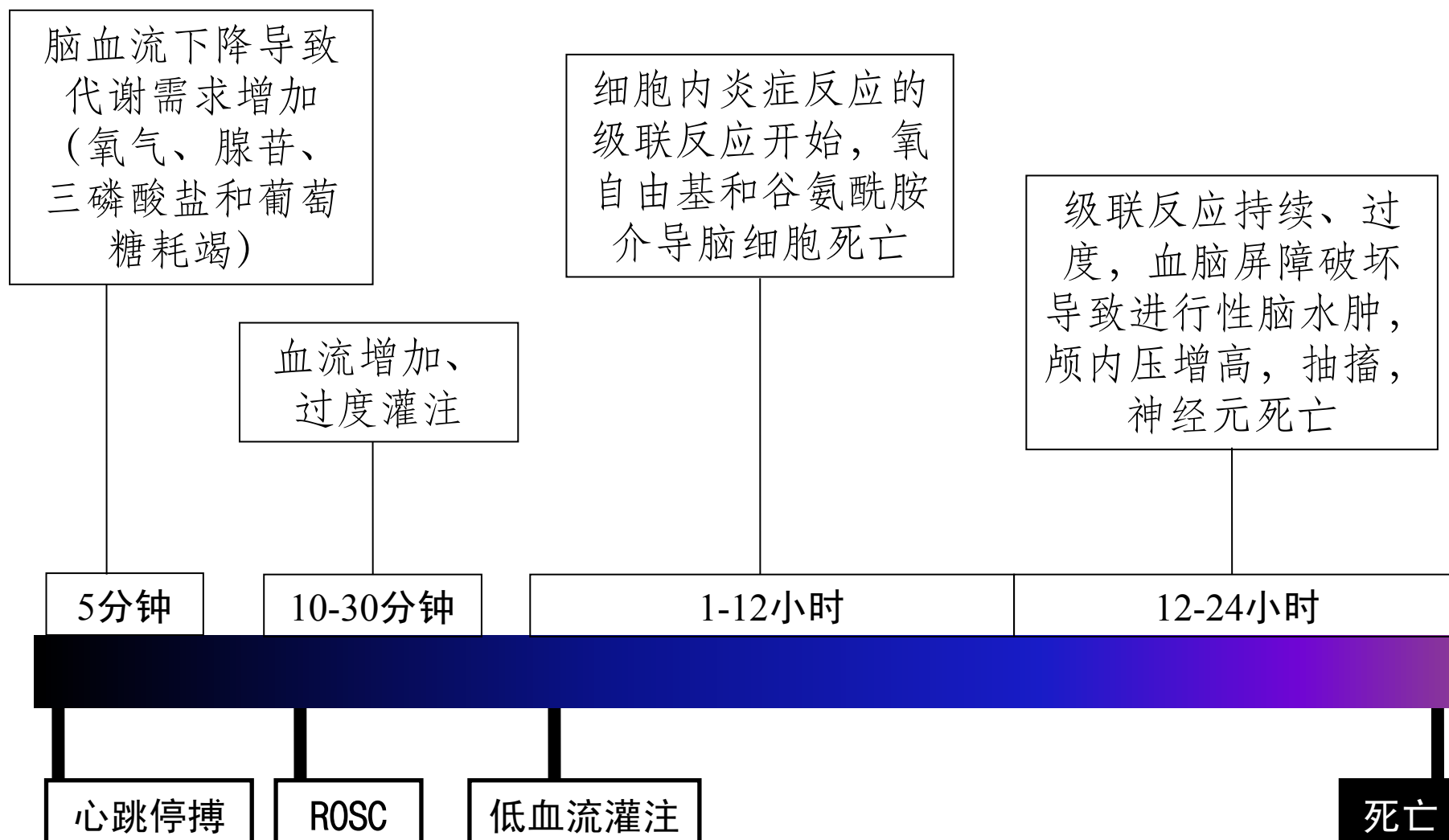
WHY

治疗性亚低温的作用机理

The post-arrest problem

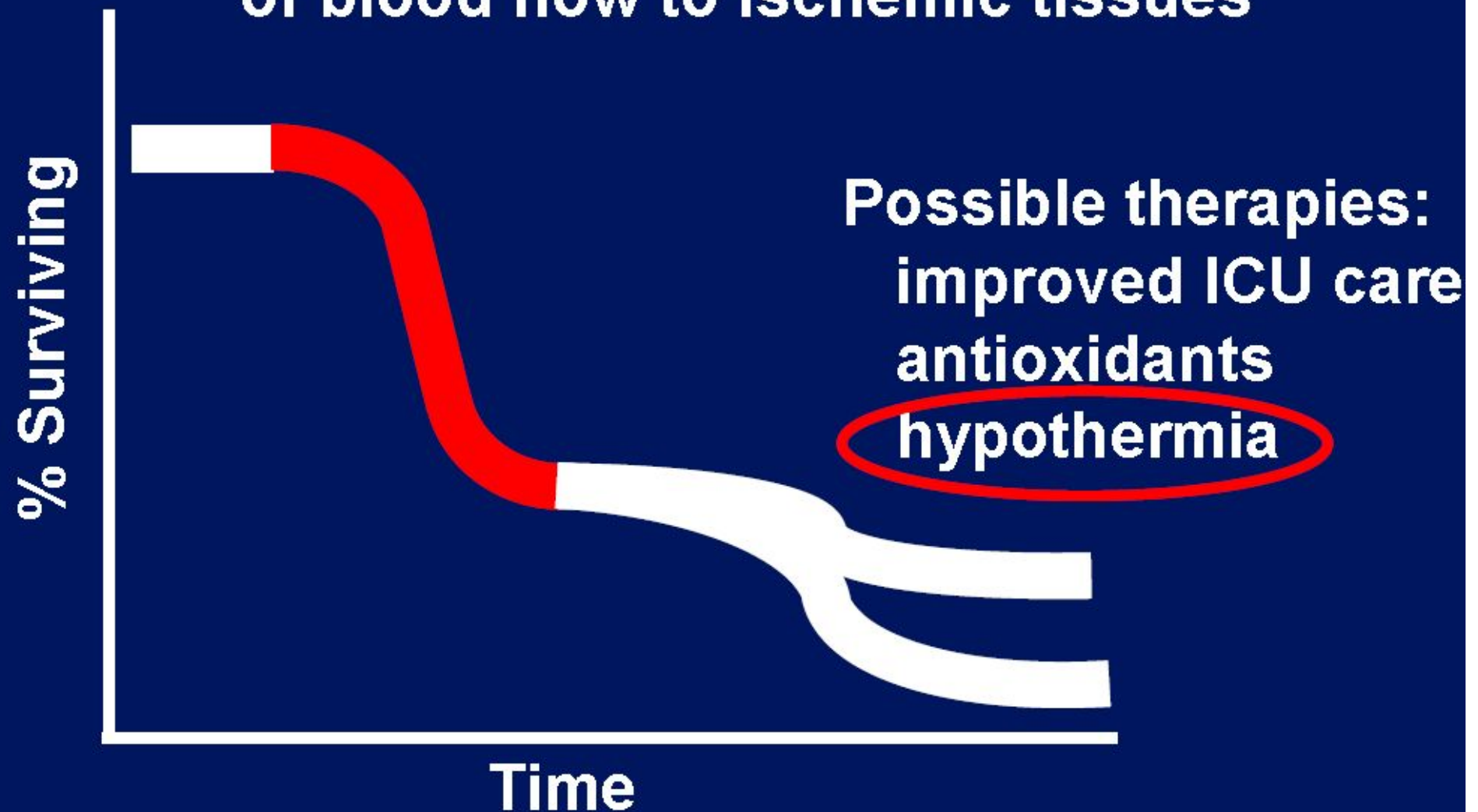


心跳骤停复苏后脑部损伤的演进



Reperfusion injury

Damage observed after restoration of blood flow to ischemic tissues



低温的保护作用

- ◎ 与意外低温不同，低温治疗通过控制性降低机体体温，对机体产生保护作用。
- ◎ 低温治疗具有多重保护效应，可同时作用于脑缺血级联损伤反应的多个靶点，减少因心跳骤停引起的全身性的缺血－再灌注损伤。
- ◎ 复苏低温治疗能够提高复苏成功率并显著改善复苏后动物的生存和神经功能预后。

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TREATMENT OF COMATOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST WITH INDUCED HYPOTHERMIA

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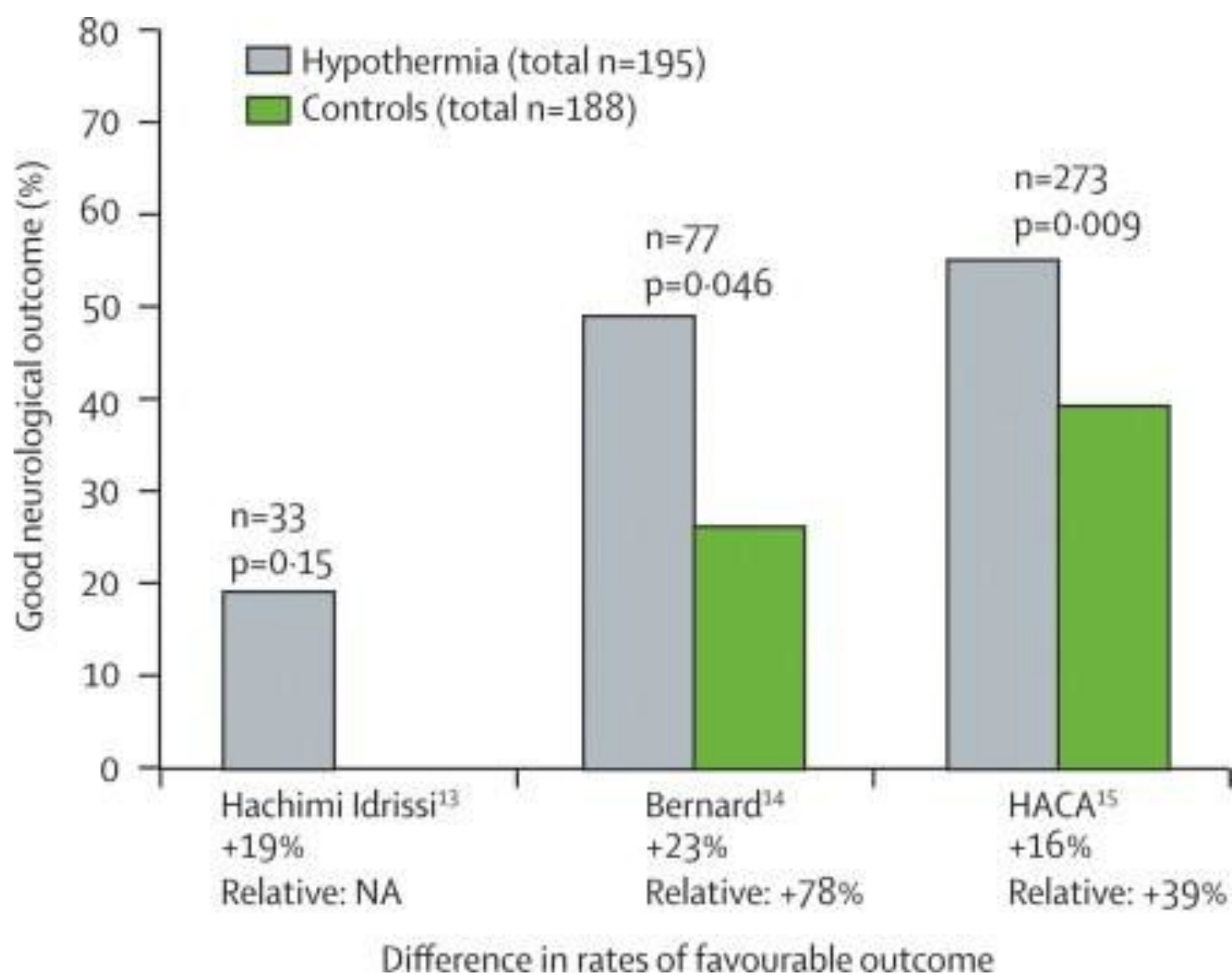
TABLE 2. NEUROLOGIC OUTCOME AND MORTALITY AT SIX MONTHS.

OUTCOME	NORMOTHERMIA	HYPOTHERMIA	RISK RATIO (95% CI)*	P VALUE†
	no./total no. (%)			
Favorable neurologic outcome‡	54/137 (39)	75/136 (55)	1.40 (1.08–1.81)	0.009
Death	76/138 (55)	56/137 (41)	0.74 (0.58–0.95)	0.02

*The risk ratio was calculated as the rate of a favorable neurologic outcome or the rate of death in the hypothermia group divided by the rate in the normothermia group. CI denotes confidence interval.

†Two-sided P values are based on Pearson's chi-square tests.

‡A favorable neurologic outcome was defined as a cerebral-performance category of 1 (good recovery) or 2 (moderate disability). One patient in the normothermia group and one in the hypothermia group were lost to neurologic follow-up.



治疗性低温保护作用机制1

- ❑ 降低机体代谢，减少脑组织对氧气和葡萄糖的消耗产生保护作用；
- ❑ 保持脂膜流动性、抑制破坏性酶反应、降低再灌注期脑低灌注区的氧需、抑制脂质过氧化、减轻脑水肿和细胞内酸中毒等。
- ❑ 减少细胞色素C释放和抑制caspase活性，从而减轻神经细胞凋亡、减少脑梗死面积。低温治疗还可能通过抑制Ca²⁺依赖性中性蛋白酶（calpain）而减轻神经细胞凋亡。
- ❑ 抑制羟基、过氧化氢等活性氧的产生，其机制尚未明确，但可带来神经保护作用。

治疗性低温保护作用机制2

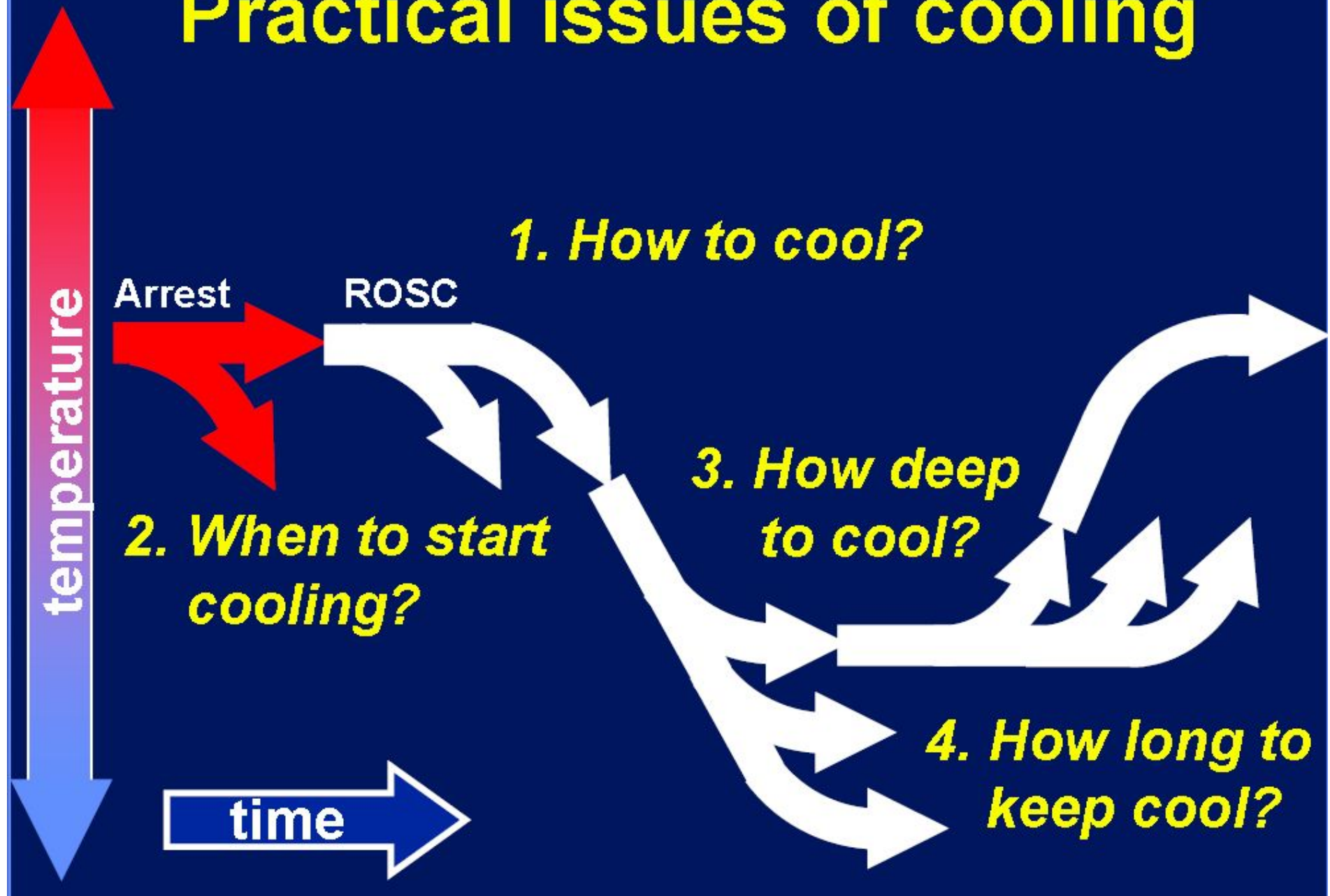
- 抑制缺血后由NF κ B激活、细胞因子释放、白细胞浸润、小胶质细胞活化以及内皮粘附分子表达等所激发的炎症反应过程的作用。
- 纠正再灌注期脑血流失调，在脑充血期和低灌注期均有调节作用。
- 低温治疗不仅对神经元具有保护作用，还可减轻脑白质损伤和抑制星形胶质细胞增殖。

Zheng Z, Yenari MA. Neurol Res. 2004;26:884-892.

Karibe H, et al. J Cereb Blood Flow Metab. 1994;14:620-627.

Roelfsema V, et al. J Cereb Blood Flow Metab. 2004;24:877-886.

Practical issues of cooling



治疗性亚低温的临床实施

WHO



ILCOR Advisory Statement

Therapeutic Hypothermia After Cardiac Arrest

**An Advisory Statement by the Advanced Life Support Task Force of the
International Liaison Committee on Resuscitation**

Writing Group

J.P. Nolan, FRCA; P.T. Morley, MD; T.L. Vanden Hoek, MD; R.W. Hickey, MD

ILCOR Recommendations

On the basis of the published evidence to date, the Advanced Life Support (ALS) Task Force of the International Liaison Committee on Resuscitation (ILCOR) made the following recommendations in October 2002:

- Unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32°C to 34°C for 12 to 24 hours when the initial rhythm was ventricular fibrillation (VF).
- Such cooling may also be beneficial for other rhythms or in-hospital cardiac arrest.



Thus, unconscious adult patients with ROSC after out-of-hospital cardiac arrest should be cooled to 32°C to 34°C (89.6°F to 93.2°F) for 12 to 24 hours when the initial rhythm was VF (Class IIa). Similar therapy may be beneficial for patients with non-VF arrest out of hospital or for in-hospital arrest (Class IIb).

因此，当初初心律为室颤（VF）时，院外心跳骤停后自主循环恢复的昏迷患者应该保持32°C-34°C低温治疗12-24小时（证据级别 II a）。同样的治疗方案对院内外非室颤骤停的病患亦可能有益（证据级别 II b）。



In summary, we recommend that comatose (ie, lack of meaningful response to verbal commands) adult patients with ROSC after out-of-hospital VF cardiac arrest should be cooled to 32°C to 34°C (89.6°F to 93.2°F) for 12 to 24 hours (Class I, LOE B). Induced hypothermia also may be considered for comatose adult patients with ROSC after in-hospital cardiac arrest of any initial rhythm or after out-of-hospital cardiac arrest with an initial rhythm of pulseless electric activity or asystole (Class IIb, LOE B). Active rewarming should be avoided in comatose patients who spontaneously develop a mild degree of hypothermia ($>32^{\circ}\text{C}$ [89.6°F]) after resuscitation from cardiac arrest during the first 48 hours after ROSC. (Class III, LOE C).

总之，我们建议对初始心律为室颤的院外心跳骤停经复苏恢复自主循环后的昏迷（例如对语言命令没有有意义的响应）成年病人实施32°C-34°C低温治疗12-24小时（证据级别 I 级，LOE B）。同样的治疗方案对院内心搏骤停（初始心律为任何心律），院外非室颤骤停的病患亦同样应用实施（证据级别 IIb，LOE B）。

WHEN

心跳骤停后复苏的损伤实质： 缺血再灌注损伤

心搏骤停前

心跳骤停期

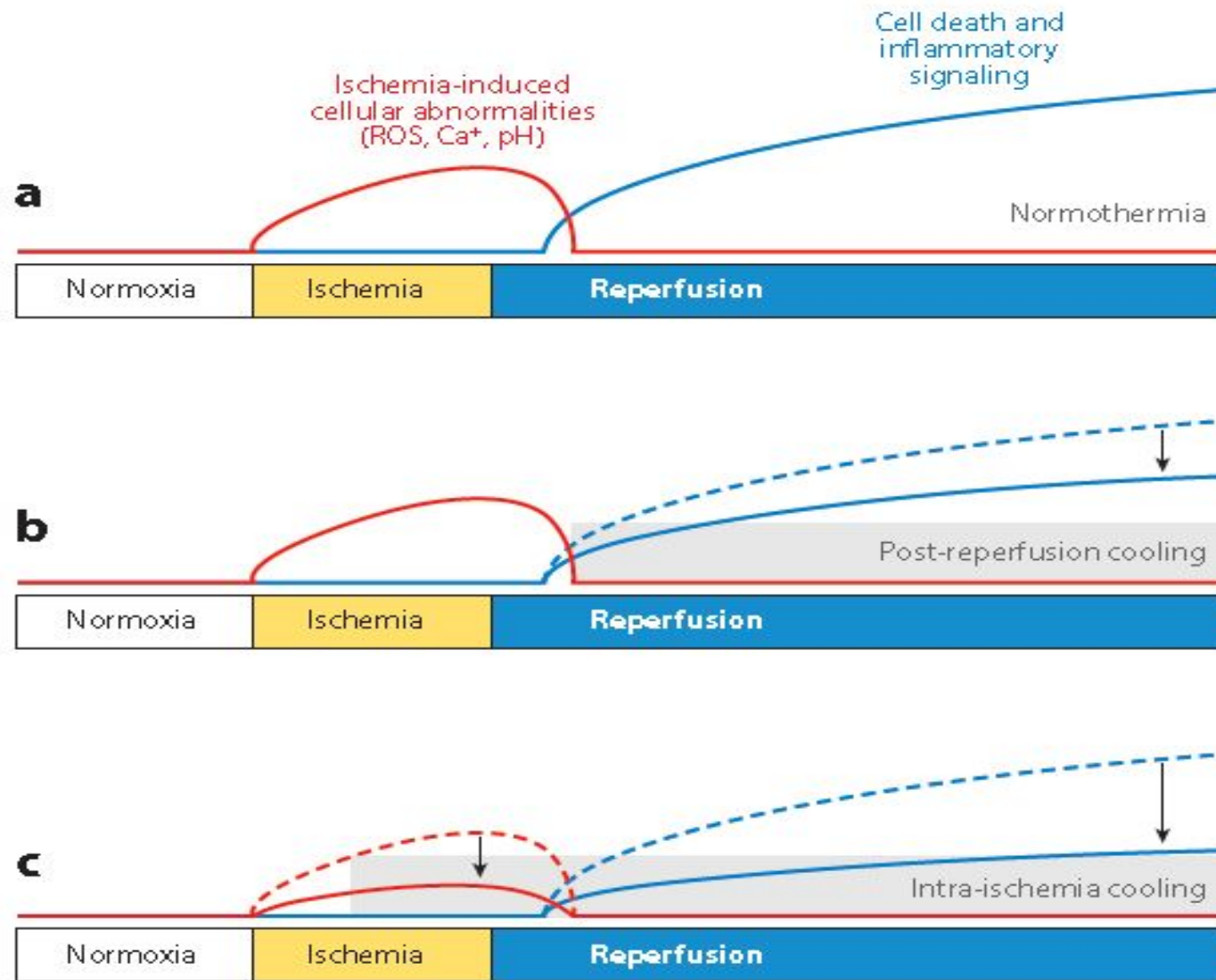
复苏及自主循环恢复后

正 常

缺 血

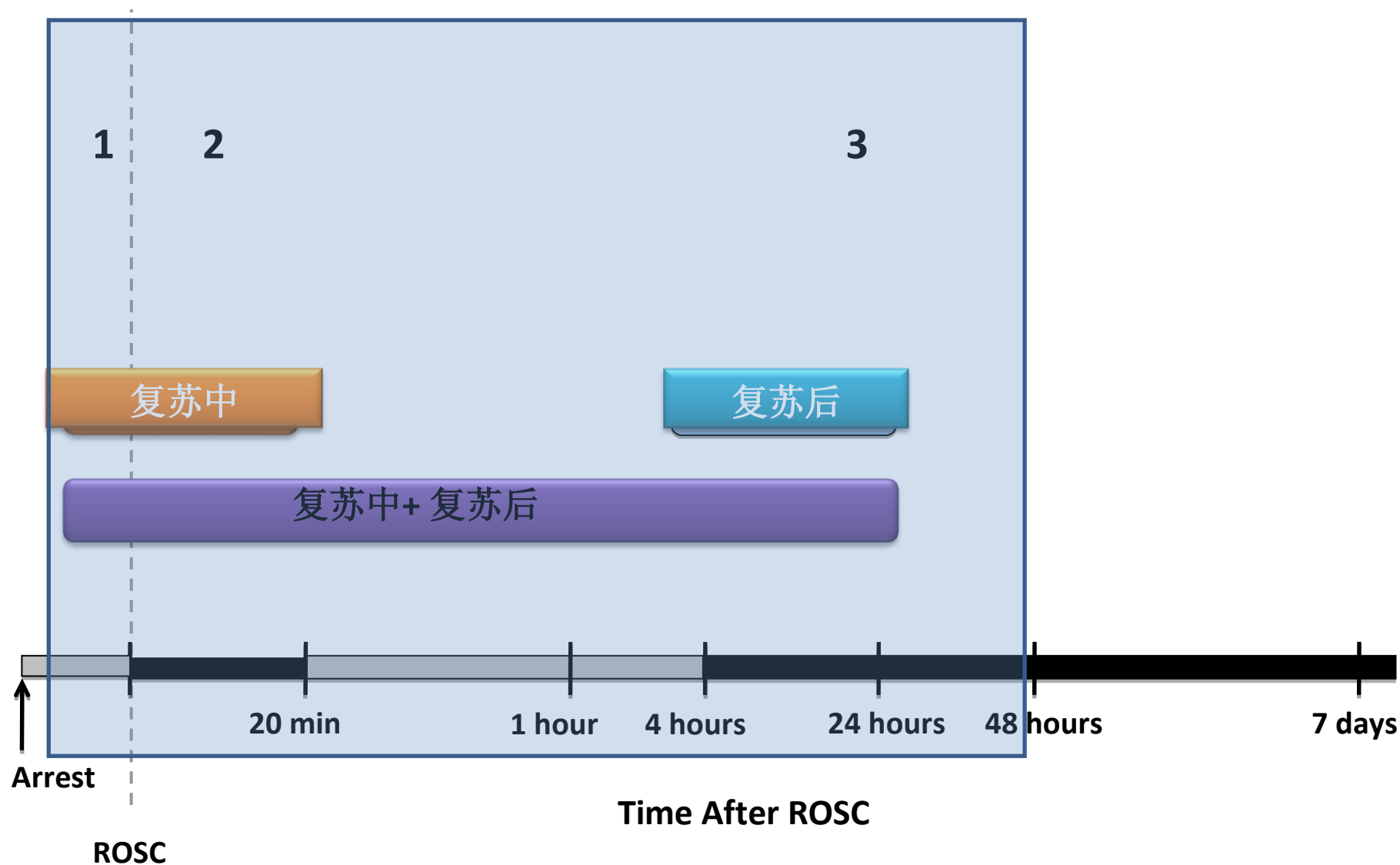
再灌注

治疗性低温应用的时机：越早越好



Lampe JW, Becker LB. State of the art in therapeutic hypothermia. Annu Rev Med. 2011;62:79-93.

亚低温治疗的时机选择



HOW



亚低温治疗的方法学

- ①表面低温：冰袋、装有循环冷却剂的冰毯、冷空气体表冷却、冰帽等；
- ②血管内低温：血管内通过导管进行血管内冷却、颈动脉冷却液体灌注、一侧颈动脉体外冷却血液灌注和4℃生理盐水灌注冷却降温等；
- ③选择性头部低温：含-30℃溶液的冰帽、冰水鼻腔灌洗、鼻咽喷射诱导脑部低温技术等；
- ④体外循环低温技术：体外膜肺（ECMO）、血液透析等；
- ⑤其他技术：例如药物诱导低温、体腔冰冻液体灌洗等技术。

The Hypothermia After Cardiac Arrest (HACA) study group. N Engl J Med. 2002;346:549-556.

Bernard SA, et al. N Engl J Med. 2002;346:557-563.

Laurent I, et al. J Am Coll Cardiol. 2005;46:432-437.

选择性头部低温的研究应用进展



选择性头部低温的方法学

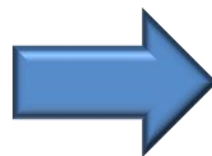






鼻咽部喷射低温技术的降温原理与顺序

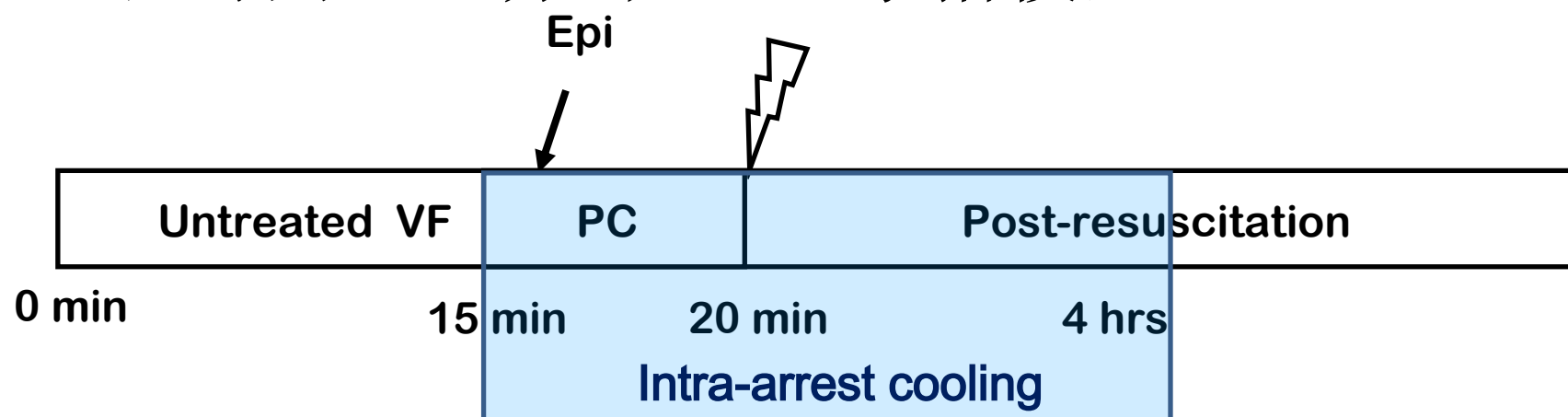
RhinoChill[®]
IntraNasal Cooling System



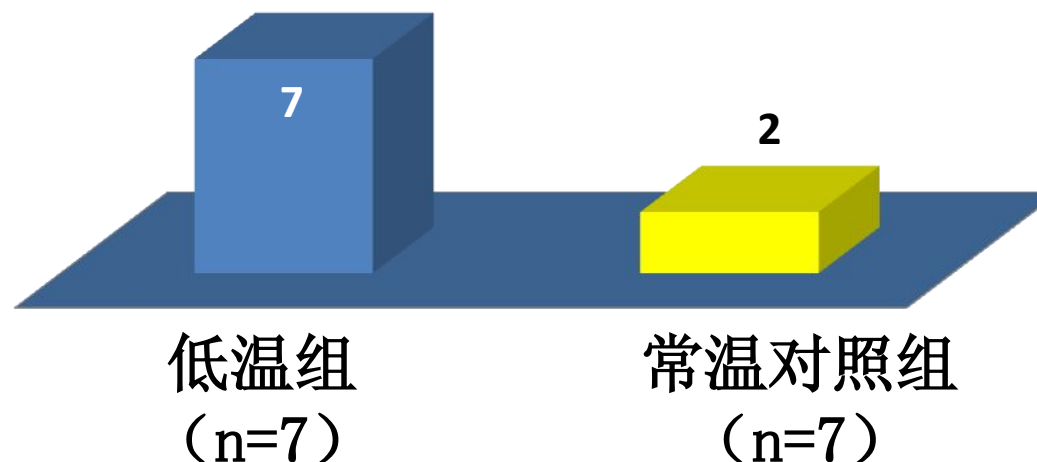
临床前期研究进展

提高心搏骤停动物复苏成功率（1）

- 长时间（15分钟）VF 家猪模型



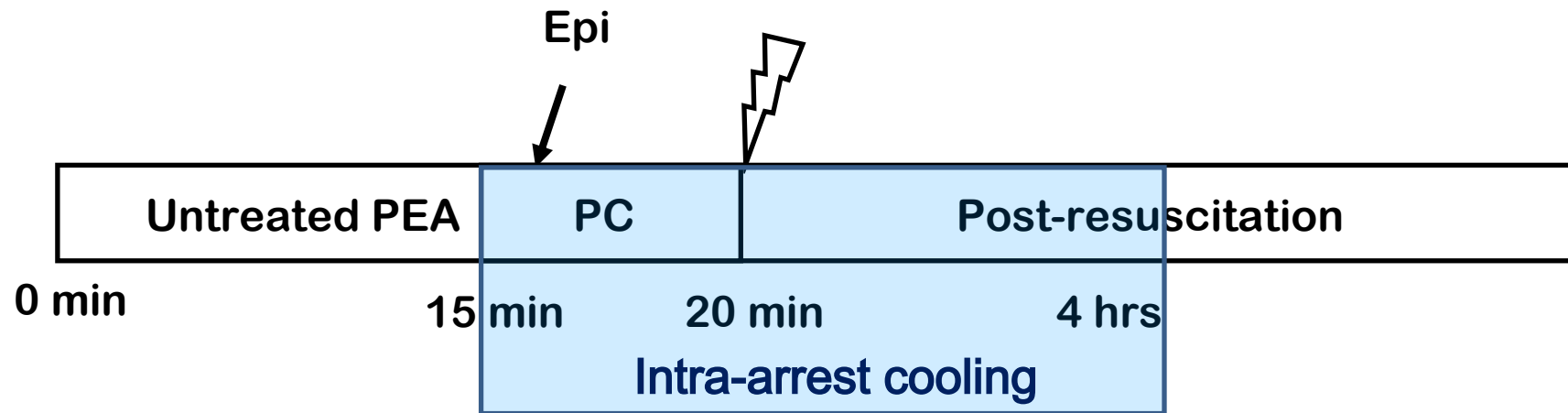
存活例数对比
(ROSC)



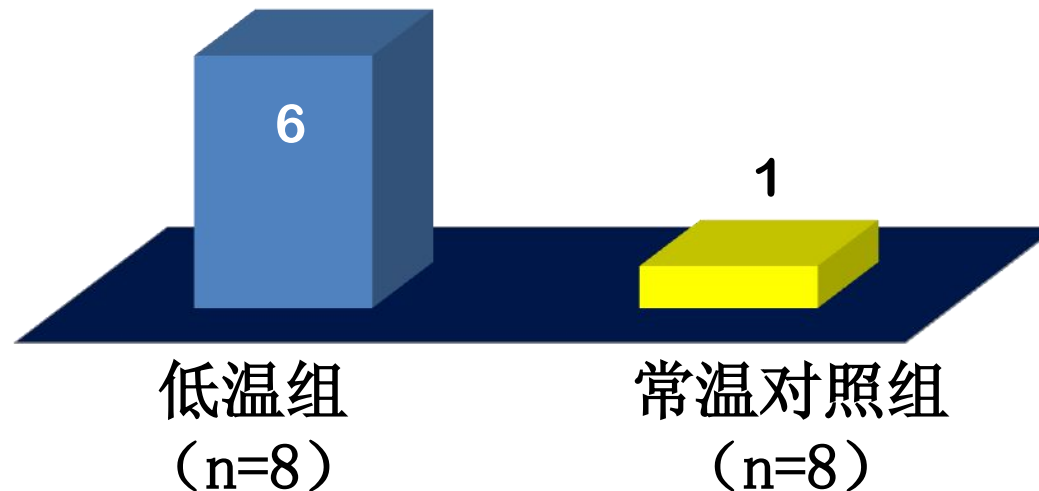
Wang H, et al Intra-arrest selective brain cooling improves success of resuscitation in a porcine model of prolonged cardiac arrest. Resuscitation. 2010 ;81(5):617-21.

提高心搏骤停动物复苏成功率（2）

- 长时间（15分钟）PEA 家猪模型



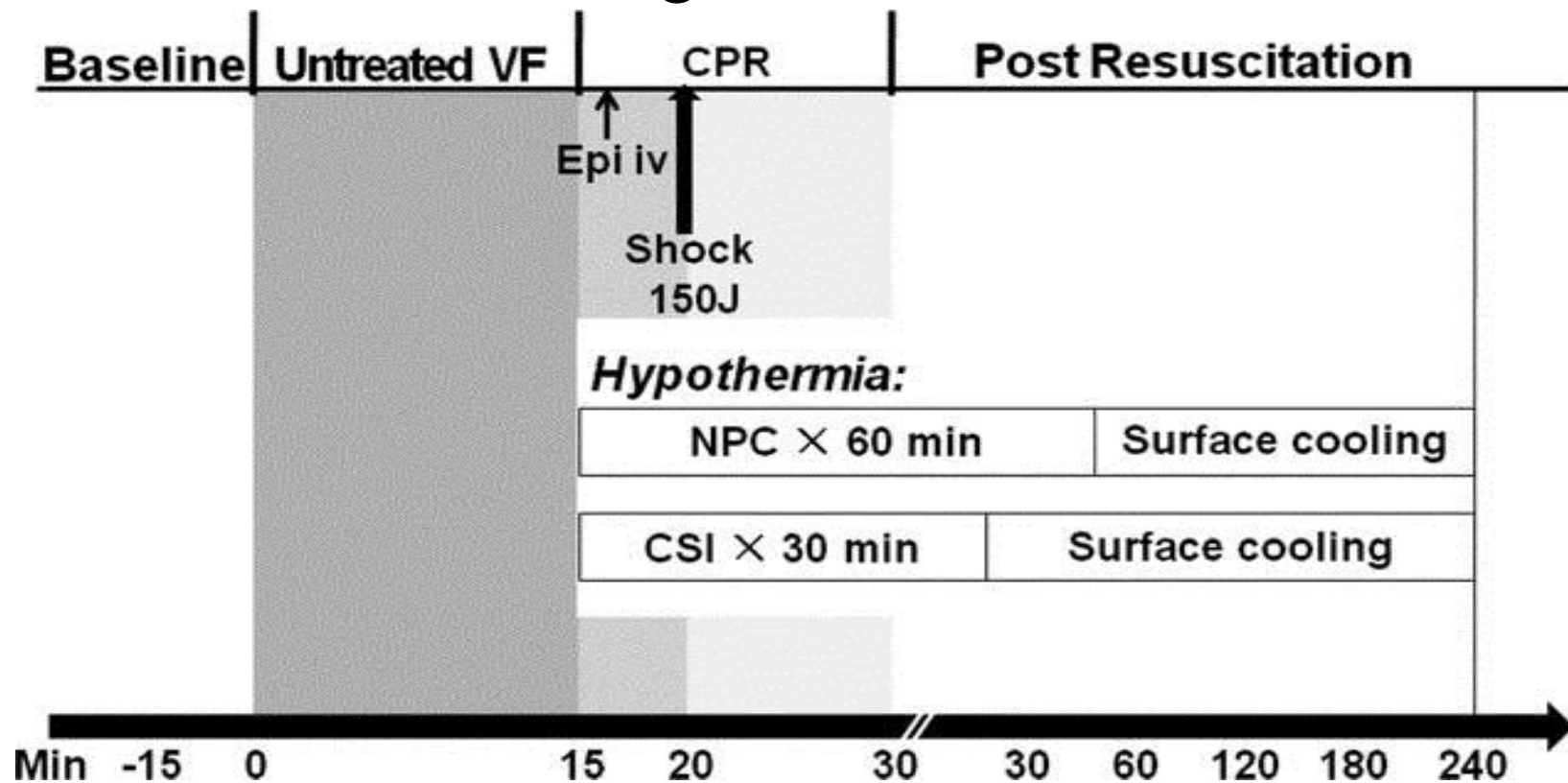
存活例数对比
(ROSC)



Cho JH, et al. Early selective trans-nasal cooling during CPR improves success of resuscitation in a porcine model of prolonged pulseless electrical activity cardiac arrest. *Resuscitation*. 2011;82(8):1071-5.

提高心搏骤停动物复苏成功率（3）

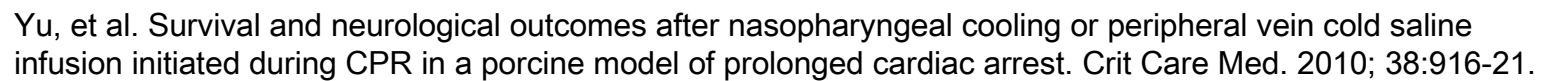
- 15分钟VF 家猪模型
- Intra-nasal cooling Vs Cold saline infusion



Yu, et al. Survival and neurological outcomes after nasopharyngeal cooling or peripheral vein cold saline infusion initiated during CPR in a porcine model of prolonged cardiac arrest. Crit Care Med. 2010; 38:916-21.

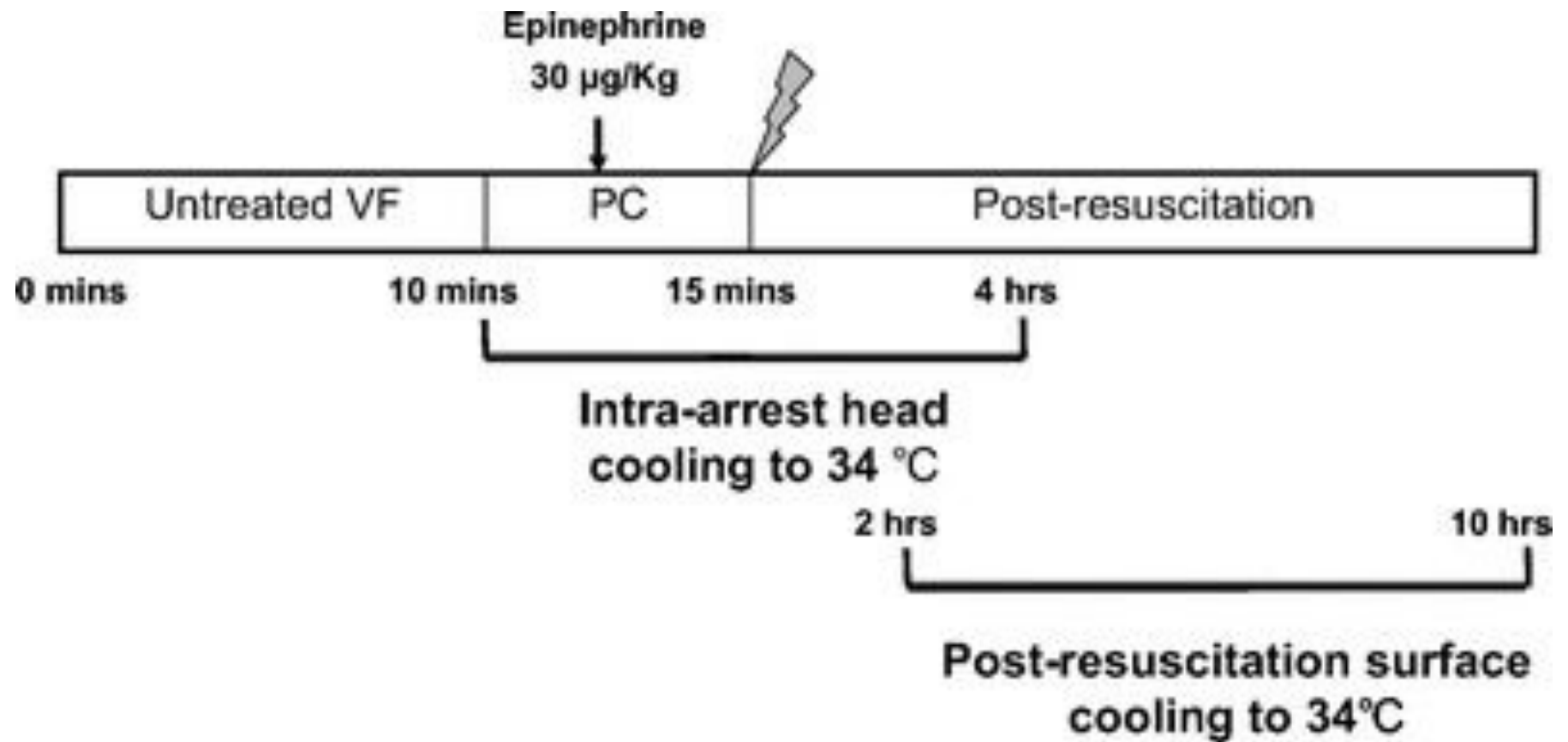
Diagram illustrating the two groups of subjects:

- 头部低温组 (n=7)**: Represented by a large blue block with the number 7.
- 冰盐水输注组 (n=7)**: Represented by a smaller yellow block with the number 2.



改善复苏后动物生存预后

- 长时间（10分钟）VF 家猪模型



Tsai, et. al. The amplitude spectrum area correctly predicts improved resuscitation and facilitated defibrillation with head cooling. Crit Care Med. 2008; 36: [Suppl.]:S413–S417.

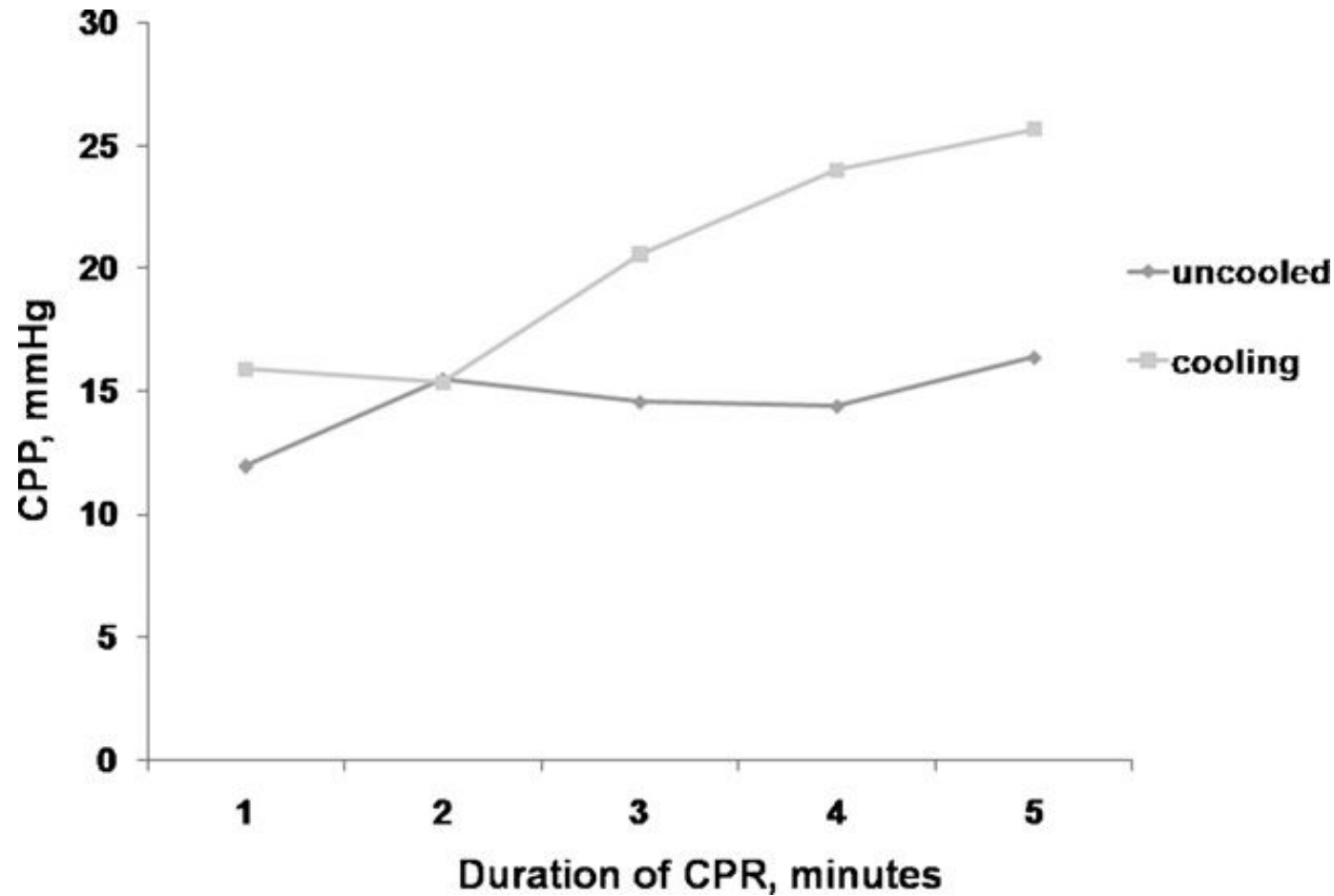
改善长时间生存预后（96小时存活率）

Table 1. Resuscitation between experimental groups

	Control n = 8	Intra-Arrest Cooling n = 8	Delayed Cooling n = 8
Body weight (kg)	40.8 ± 1.9	40.4 ± 0.7	41.1 ± 3.7
CPR duration (sec)	612.9 ± 227.3	364.6 ± 42.4	422.4 ± 201.1
Epinephrine dosage (μg/kg)	60 ± 32.1	30 ± 0	42 ± 31.8
CPP before initial electrical shock (mm Hg)	17.7 ± 5.6	21.3 ± 9.6	19.6 ± 7.94
Total shock number	14.8 ± 8.8	8.1 ± 4.6	5.5 ± 3.3
Initial shock success (%)	38	75	63
Total shock success (%)	66 ± 19	88 ± 18	74 ± 34
ROSC	7 (88%)	8 (100%)	7 (88%)
Survival for 96 hrs	2 (25%)	8 (100%)	5 (63%)

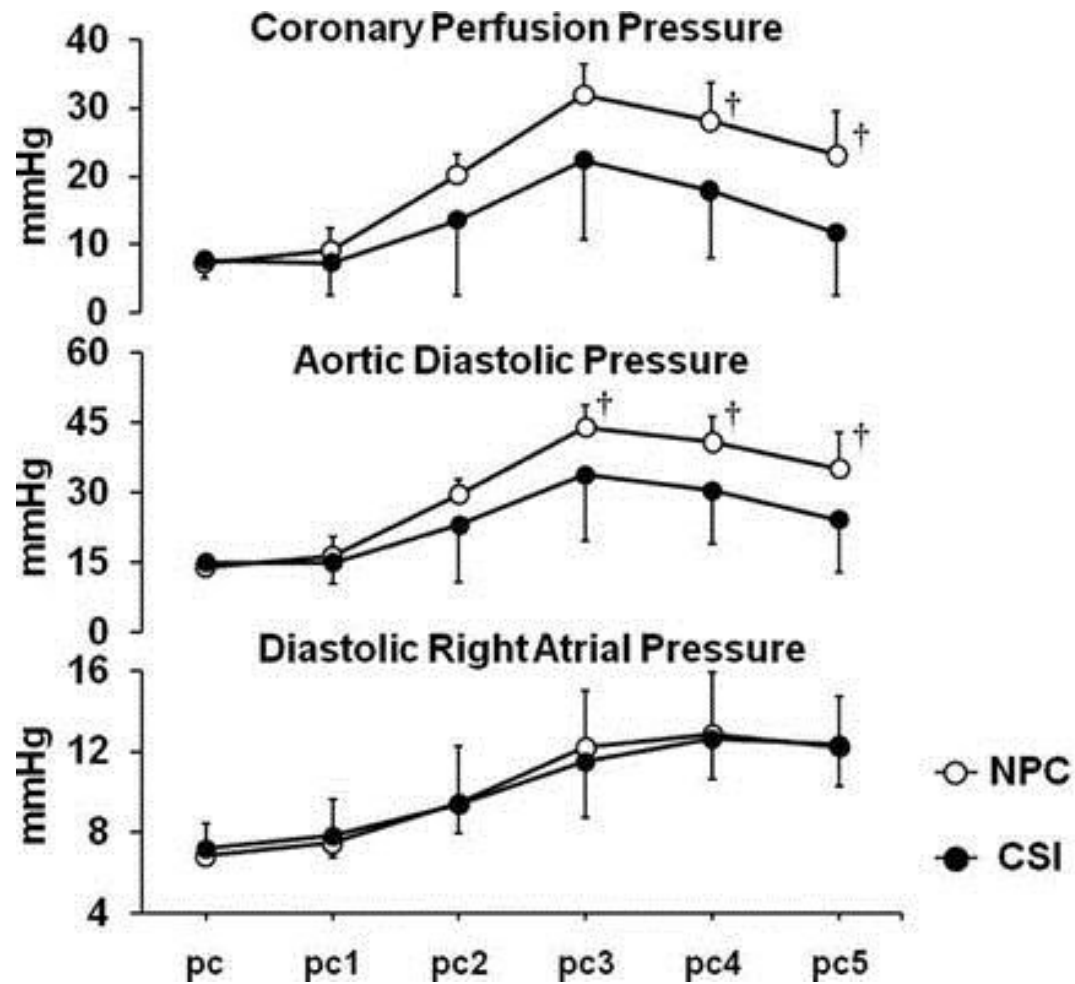
Tsai, et. al. The amplitude spectrum area correctly predicts improved resuscitation and facilitated defibrillation with head cooling. Crit Care Med. 2008; 36: [Suppl.]:S413–S417.

提高冠脉灌注压（CPP）—VF 模型（1）



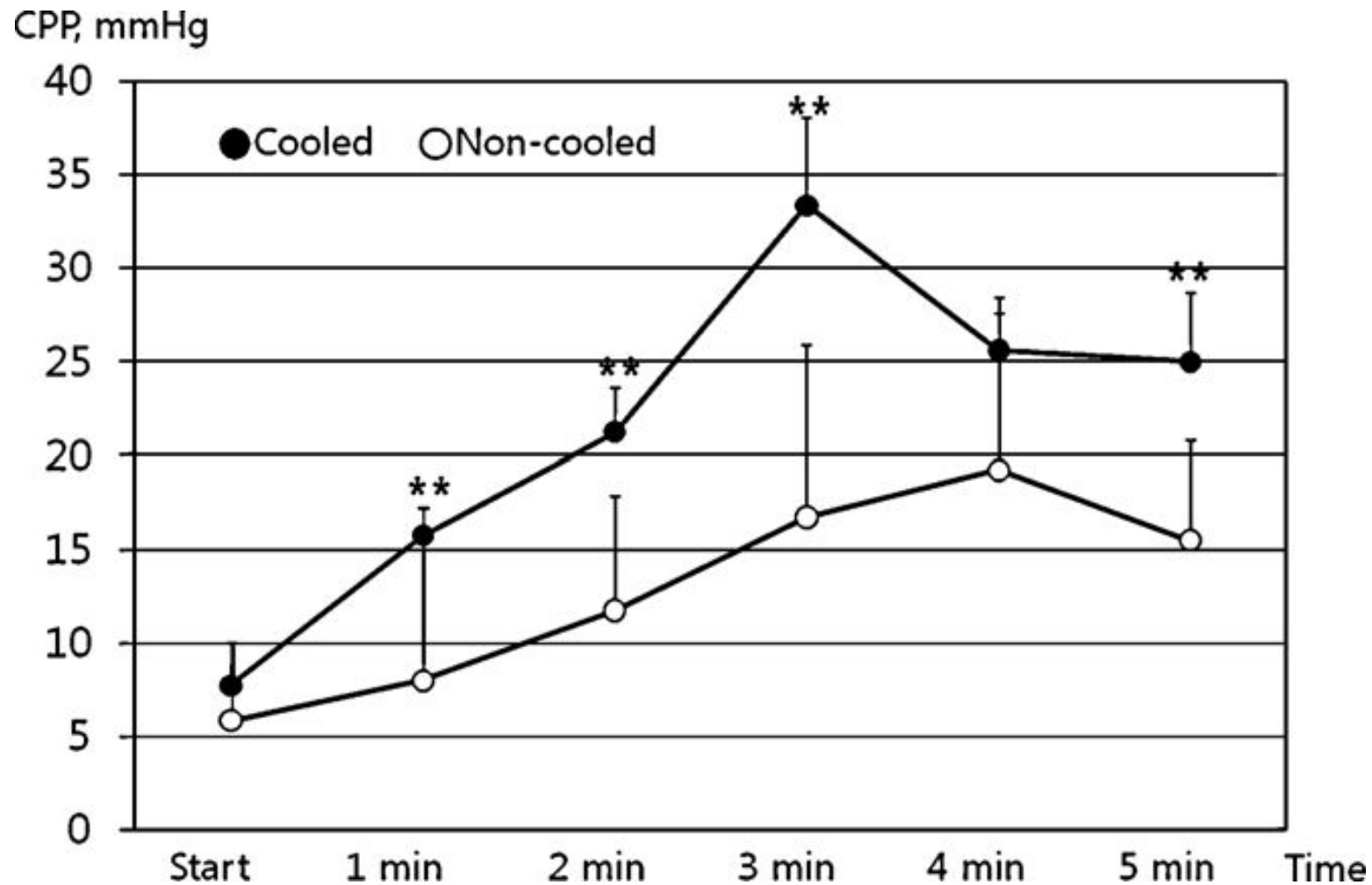
Wang H, et al Intra-arrest selective brain cooling improves success of resuscitation in a porcine model of prolonged cardiac arrest. Resuscitation. 2010 ;81(5):617-21.

提高冠脉灌注压（CPP）—VF 模型（2）



Yu, et al. Survival and neurological outcomes after nasopharyngeal cooling or peripheral vein cold saline infusion initiated during CPR in a porcine model of prolonged cardiac arrest. Crit Care Med. 2010; 38:916-21.

提高冠脉灌注压（CPP）——PEA 模型



Cho JH, et al. Early selective trans-nasal cooling during CPR improves success of resuscitation in a porcine model of prolonged pulseless electrical activity cardiac arrest. *Resuscitation*. 2011;82(8):1071-5.

改善复苏后动物心功能——VF 模型

Table 2. Hemodynamic and echocardiographic measurements between experimental groups

	Baseline	PR 1 hr	PR 2 hr	PR 3 hr	PR 4 hr	PR 96 hr
HR (min)						
Intra-arrest cooling	104.0 ± 13.5	157.5 ± 36.5 ^a	135.8 ± 23.9 ^b	136.3 ± 24.8 ^{b,c}	134.5 ± 24.7 ^{b,d}	109.1 ± 25.5
Delayed cooling	106.1 ± 13.6	176.7 ± 18.9 ^a	182.0 ± 24.5	181.8 ± 17.4 ^a	167.3 ± 19.5 ^b	123.2 ± 20.1
Control	119.8 ± 21.4	205.3 ± 18.6	209.0 ± 23.2	207.0 ± 8.3	215.4 ± 23.5	144.0 ± 33.9
MAP (mm Hg)						
Intra-arrest cooling	115.5 ± 12.1	103.5 ± 9.7	108.8 ± 15.2	120.3 ± 12.4	125.8 ± 14.5	NA
Delayed cooling	124.1 ± 9.2	110.0 ± 7.9	120.6 ± 8.8	128.4 ± 13.2	126.6 ± 6.4	NA
Control	122.9 ± 13.6	113.3 ± 14.9	123.3 ± 18.1	122.4 ± 13.1	122.0 ± 12.4	NA
E/A						
Intra-arrest cooling	1.32 ± 0.06	1.23 ± 0.16 ^d	1.24 ± 0.16 ^d	1.30 ± 0.15	1.30 ± 0.15 ^d	1.32 ± 0.09
Delayed cooling	1.12 ± 0.09	1.438 ± 0.188	1.51 ± 0.25	1.49 ± 0.14	1.63 ± 0.23 ^a	1.35 ± 0.13
Control	1.35 ± 0.09	1.25 ± 0.41	1.37 ± 0.27	1.46 ± 0.22	1.46 ± 0.22	1.18 ± 0.08
DT (sec)						
Intra-arrest cooling	0.13 ± 0.02	0.07 ± 0.01 ^a	0.09 ± 0.02 ^a	0.10 ± 0.01 ^{b,d}	0.11 ± 0.02 ^a	0.14 ± 0.02 ^a
Delayed cooling	0.13 ± 0.01	0.08 ± 0.01	0.08 ± 0.01	0.08 ± 0.01 ^a	0.09 ± 0.01 ^a	0.14 ± 0.02 ^a
Control	0.11 ± 0.02	0.06 ± 0.01	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01	0.09 ± 0.01
S/D						
Intra-arrest cooling	1.08 ± 0.05	0.80 ± 0.12 ^c	1.06 ± 0.08 ^b	1.07 ± 0.06 ^{bb}	1.07 ± 0.06 ^d	1.07 ± 0.05
Delayed cooling	1.12 ± 0.09	0.83 ± 0.05	0.84 ± 0.05	0.91 ± 0.10	1.02 ± 0.10 ^a	1.07 ± 0.03
Control	1.05 ± 0.03	0.80 ± 0.07	0.83 ± 0.07	0.90 ± 0.07	1.02 ± 0.10	1.04 ± 0.08
MPI						
Intra-arrest cooling	0.52 ± 0.03	0.69 ± 0.06 ^{a,d}	0.63 ± 0.08 ^{a,c}	0.56 ± 0.05 ^{a,c}	0.52 ± 0.01 ^{b,c}	0.52 ± 0.03 ^{a,d}
Delayed cooling	0.63 ± 0.22	35.26 ± 4.32	37.62 ± 2.62	37.35 ± 2.83	38.51 ± 5.77	45.72 ± 3.32
Control	0.51 ± 0.03	0.91 ± 0.24	0.90 ± 0.23	0.88 ± 0.32	0.78 ± 0.07	0.65 ± 0.13

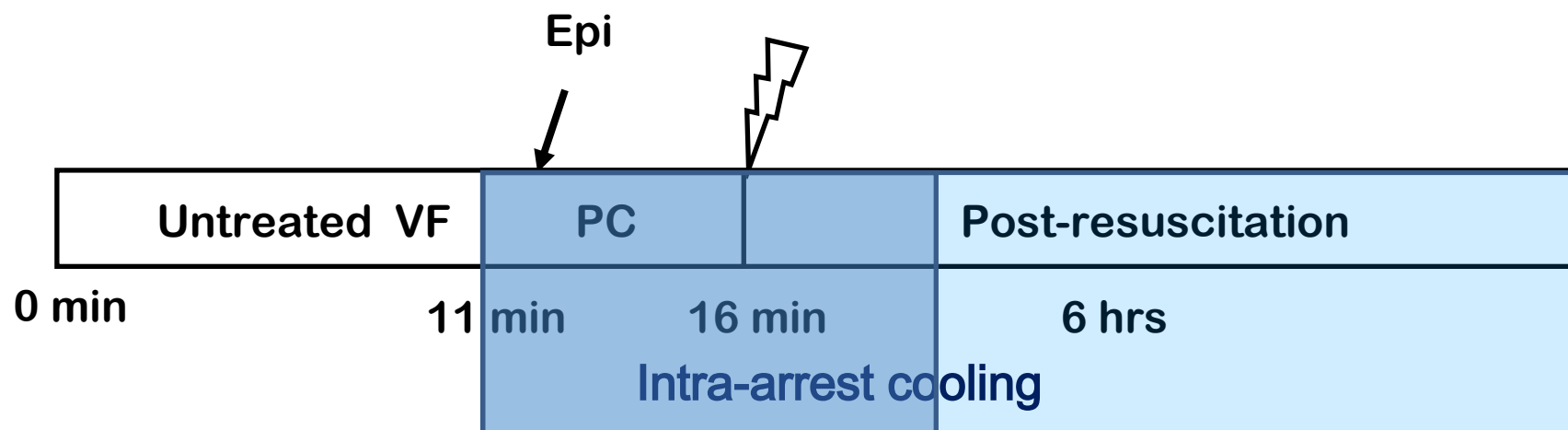
DT, decelerating time; HR, heart rate; MAP, mean arterial pressure; MPI, myocardial performance index; NA, not available; PR, postresuscitation; S/D, systolic/diastolic.

^a*p* < 0.05; ^b*p* < 0.005 when compared with control group; ^c*p* < 0.001 when compared with delayed cooling group; ^d*p* < 0.05.

Tsai, et. al. The amplitude spectrum area correctly predicts improved resuscitation and facilitated defibrillation with head cooling. Crit Care Med. 2008; 36: [Suppl.]:S413–S417.

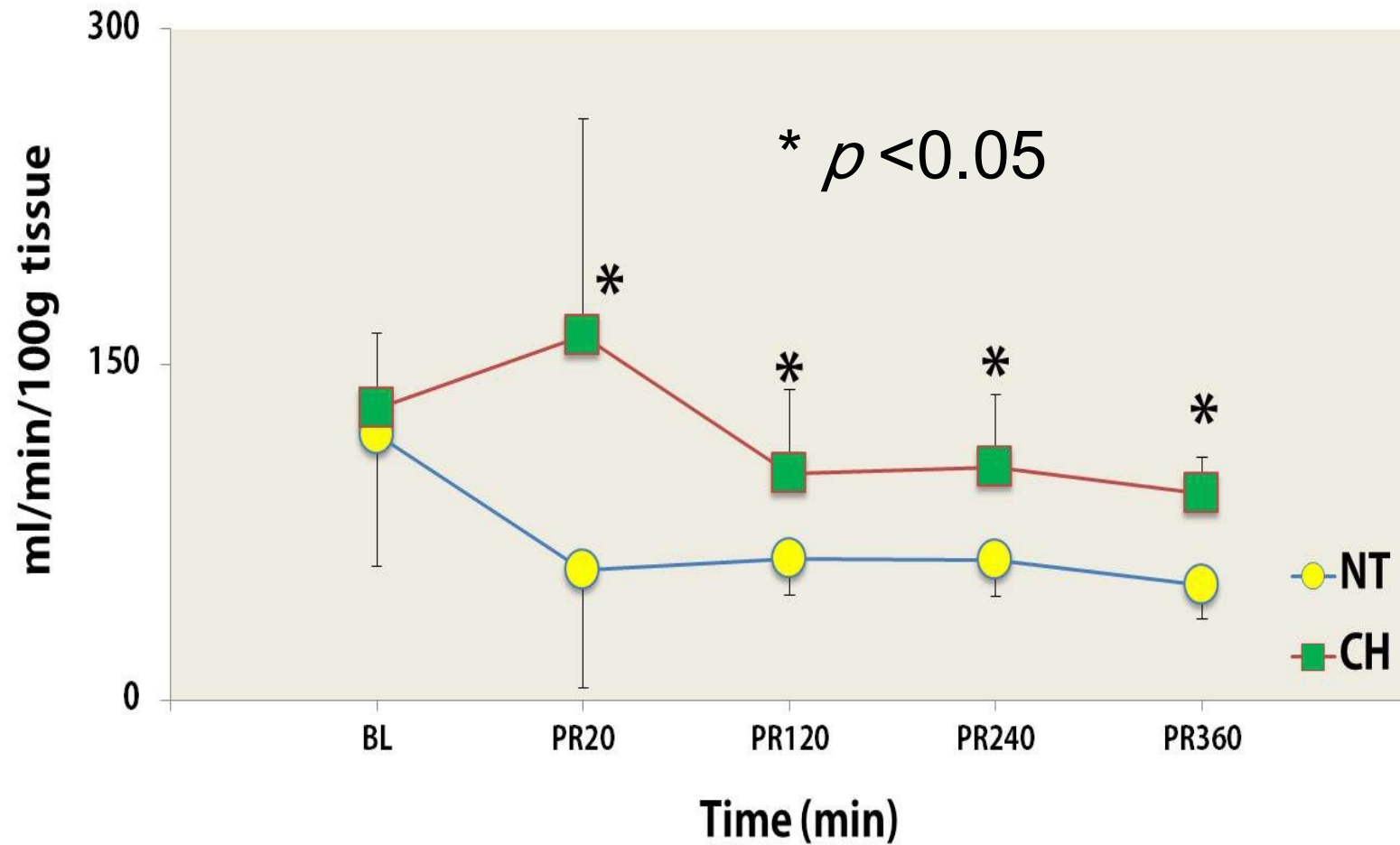
选择性头部低温保护机制探讨

- 长时间（11分钟）VF 家猪模型

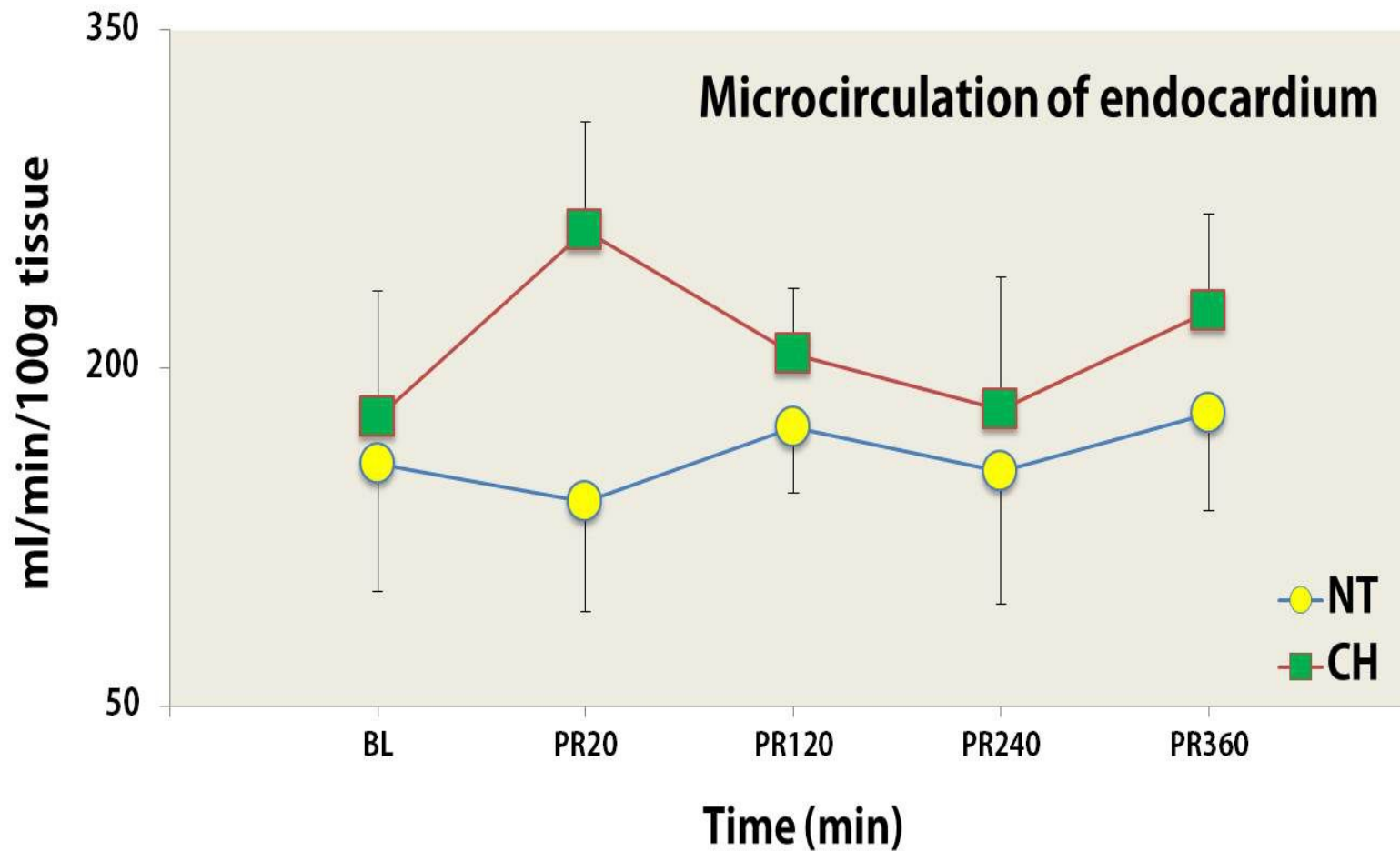


1. 微球法检测脑部和心肌的微循环
2. 测量复苏后外周血儿茶酚胺的浓度

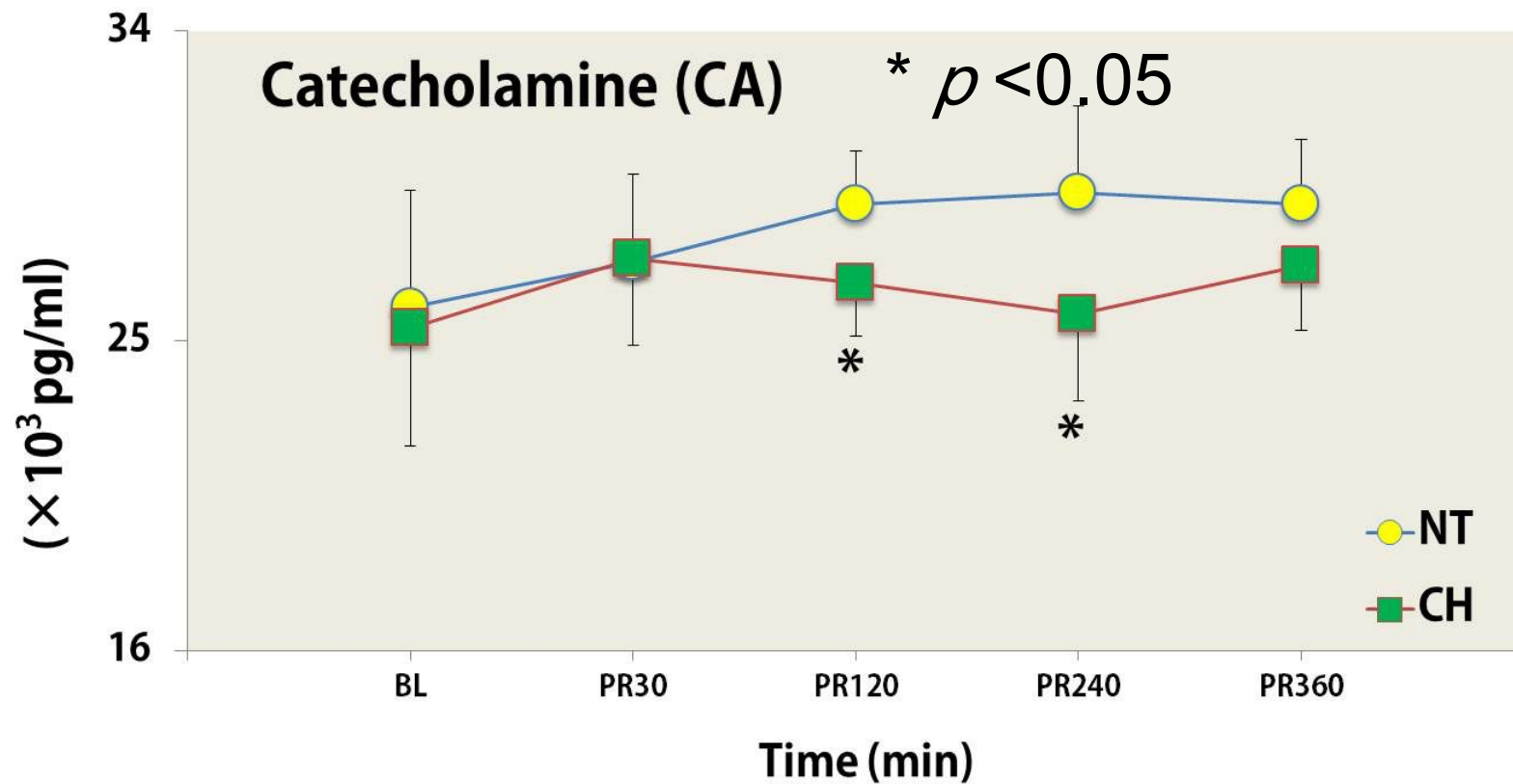
改善复苏后动物脑部皮层的血流灌注



改善复苏后动物心肌的血流灌注



降低外周血的儿茶酚胺的浓度



临床研究进展

ER Study

PRINCE Study

ER Study



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Resuscitation

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Clinical paper

Safety and feasibility of nasopharyngeal evaporative cooling in the emergency department setting in survivors of cardiac arrest[☆]

H.-J. Busch^a, F. Eichwede^b, M. Födisch^c, F.S. Taccone^d, G. Wöbker^e, T. Schwab^a, H.-B. Hopf^f, P. Tonner^g, S. Hachimi-Idrissi^h, P. Martensⁱ, H. Fritz^j, Ch. Bode^a, J.-L. Vincent^d, B. Inderbitzen^k, D. Barbut^k, F. Sterz^{l,*}

^a Albert Ludwigs University Freiburg, Department of Cardiology and Angiology, Freiburg i. Br., Germany

^b Medizinisches Zentrum Aachen, Department of Anesthesia and Intensive Care, Würselen, Germany

^c Evangelisches Waldkrankenhaus, Department of Anesthesia and Intensive and Emergency Care, Bonn, Germany

^d Erasme University Hospital, Department of Intensive Care, Université Libre de Bruxelles, Brussels, Belgium

^e HELIOS Klinikum Wuppertal, Department of Intensive Care, Wuppertal, Germany

^f Asklepios Klinik Langen, Department of Anesthesia and Intensive Care, Langen, Germany

^g Klinikum Links der Weser, Department of Anesthesia and Intensive Care, Bremen, Germany

^h Universitair Ziekenhuis Brussel, Critical Care Medicine and Cerebral Resuscitation Research Group, Brussels, Belgium

ⁱ Algemeen Ziekenhuis Sint-Jan, Department of Anaesthesia and Critical Care, Brugge, Belgium

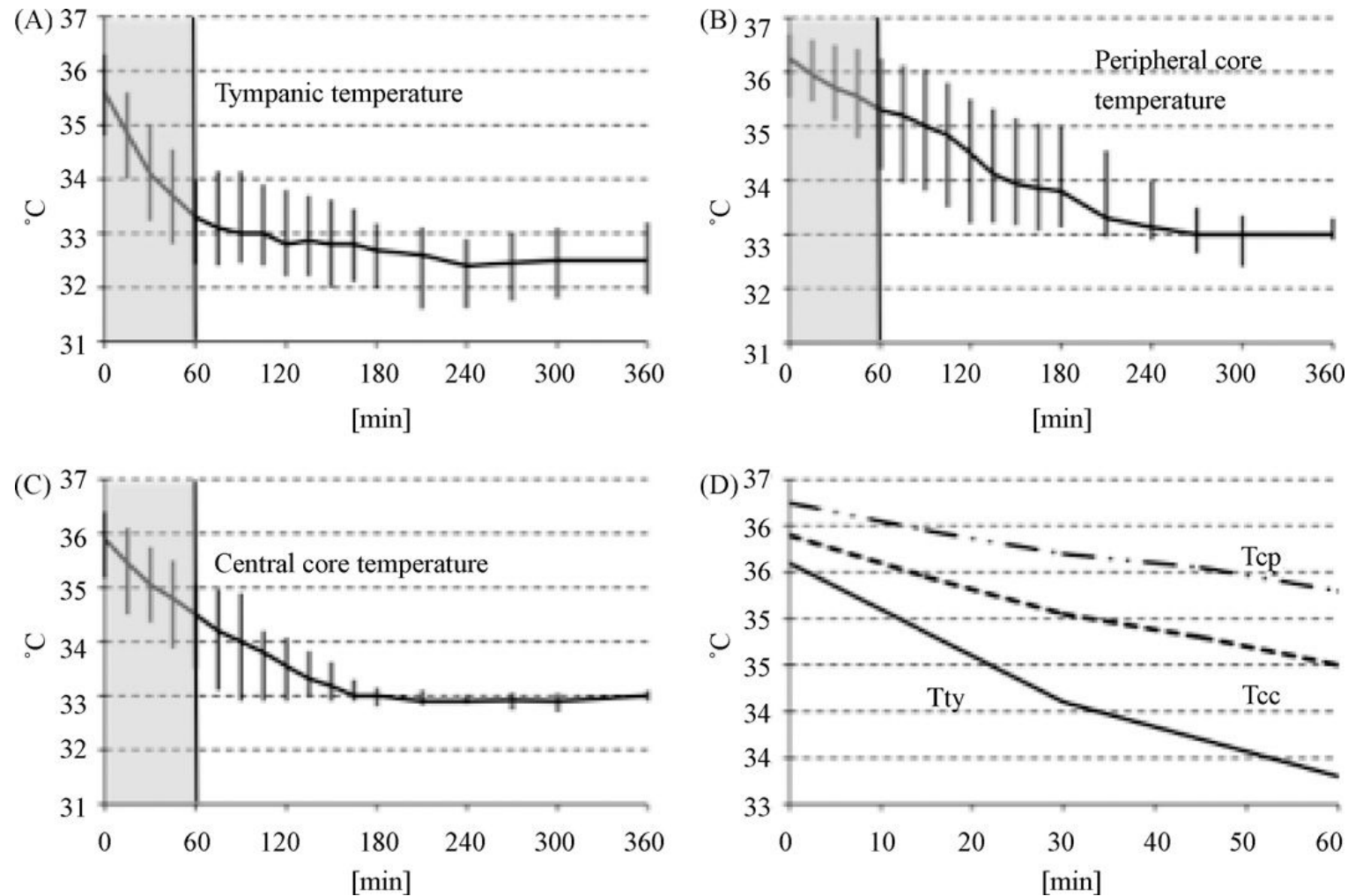
^j Krankenhaus Martha-Maria Halle-Dölau, Department of Anesthesia and Intensive Care, Halle/Salle, Germany

^k BeneChill Inc., San Diego, USA

^l Medical University of Vienna, Department of Emergency Medicine, Währingergürtel 18-20, 1090 Vienna, Austria

Busch; Safety and feasibility of nasopharyngeal evaporative cooling in the emergency department setting in survivors of cardiac arrest 84 cardiac arrest patients. Resuscitation 2010;81:943-9 Aug 2010

鼻咽喷射能够快速降低头部及核心体温



Busch; Safety and feasibility of nasopharyngeal evaporative cooling in the emergency department setting in survivors of cardiac arrest 84 cardiac arrest patients. Resuscitation 2010;81:943-9 Aug 2010

低温诱导装置安全、可靠

Table 3

Device related adverse events.

	Total incidence	Resolved	Sequelae
Device related events	15/84 (16%)		
Nasal discoloration	10/84 (11%)	10 (11%)	
Cold-induced tissue damage	1/84 (1%)	0	1 (1%)
Epistaxis	2/84 (2%)	2 (2%)	0
Coolant in sinus	1/84 (1%)	1 (1%)	0
Periorbital gas emphysema	1/84 (1%)	1 (1%)	0

PRINCE Study

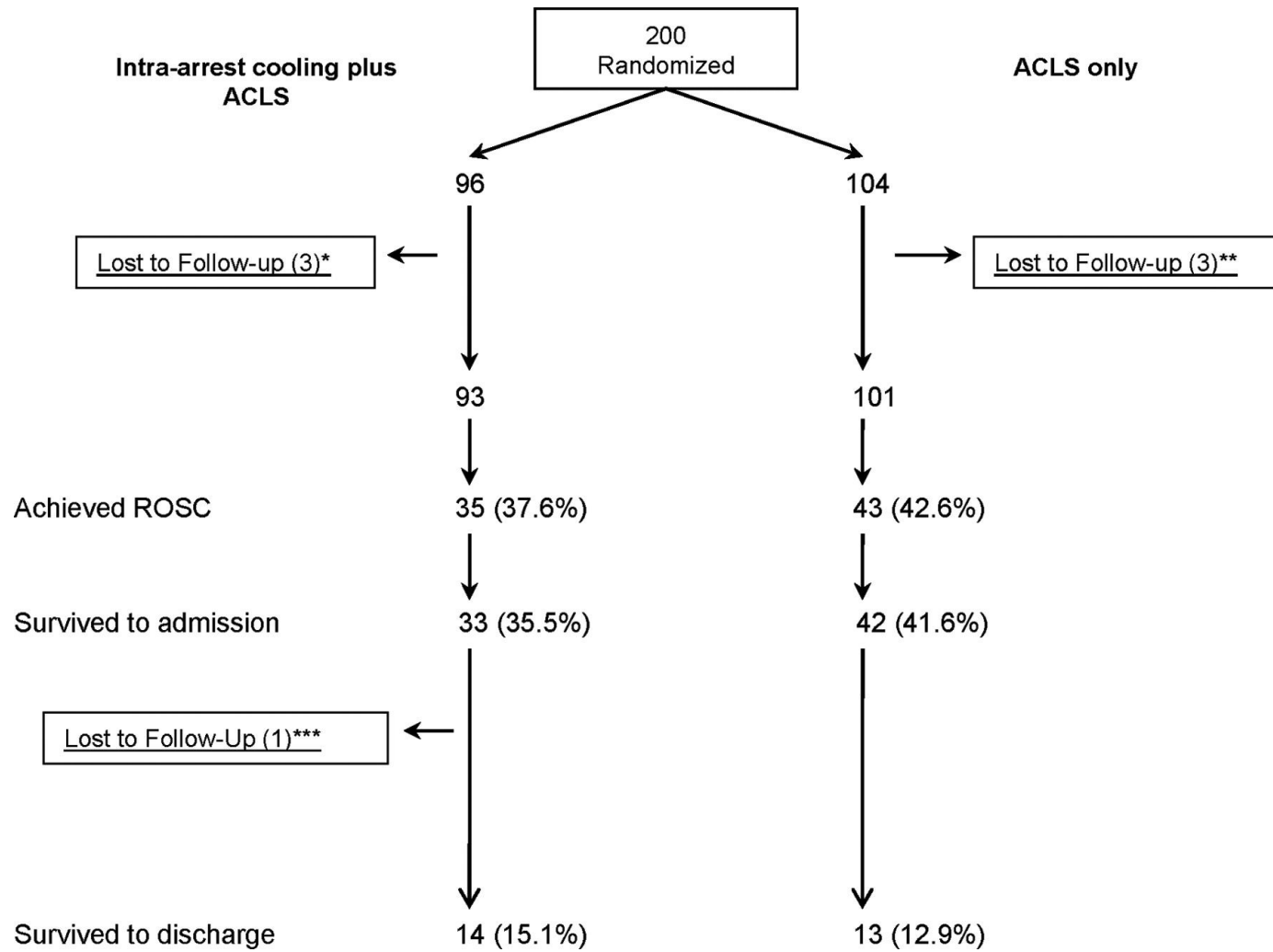


Intra-Arrest Transnasal Evaporative Cooling: A Randomized, Prehospital, Multicenter Study (PRINCE: Pre-ROSC IntraNasal Cooling Effectiveness)

Maaret Castrén, Per Nordberg, Leif Svensson, Fabio Taccone, Jean-Louise Vincent, Didier Desruelles, Frank Eichwede, Pierre Mols, Tilmann Schwab, Michel Vergnion, Christian Storm, Antonio Pesenti, Jan Pachl, Fabien Guérisse, Thomas Elste, Markus Roessler, Harald Fritz, Pieterjan Durnez, Hans-Jörg Busch, Becky Inderbitzen and Denise Barbut

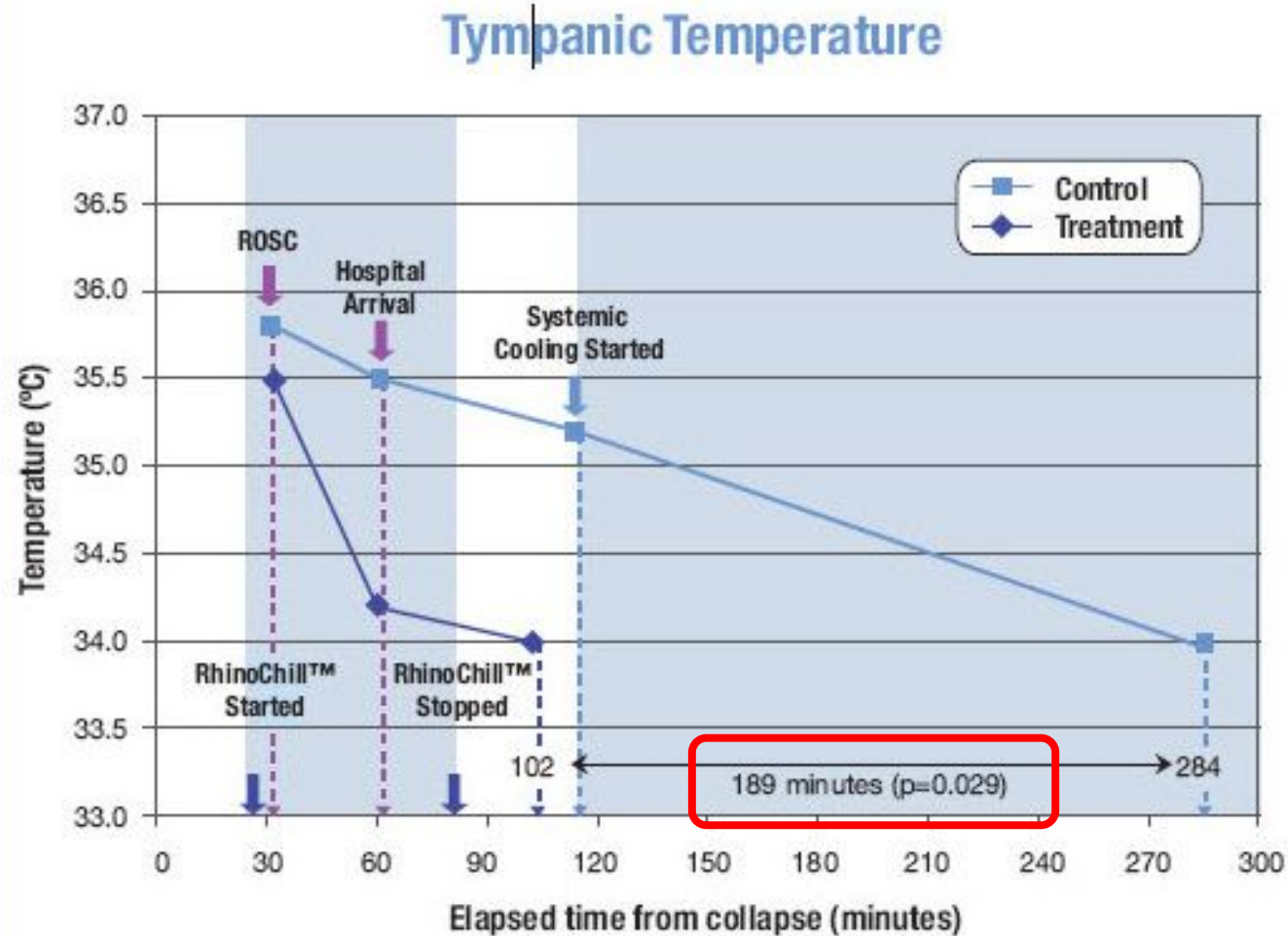
Circulation. 2010;122:729-736; originally published online August 2, 2010;

研究设计

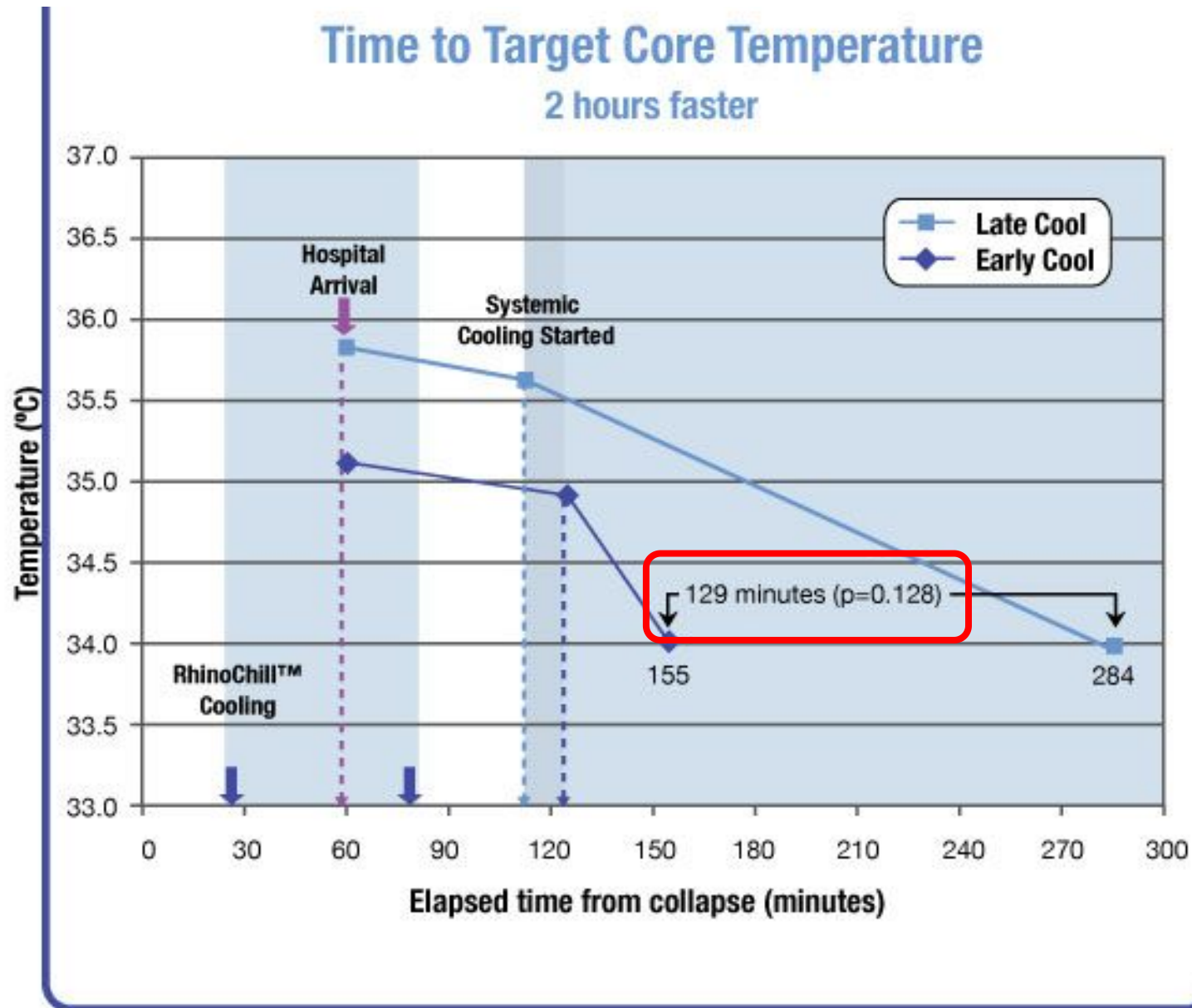




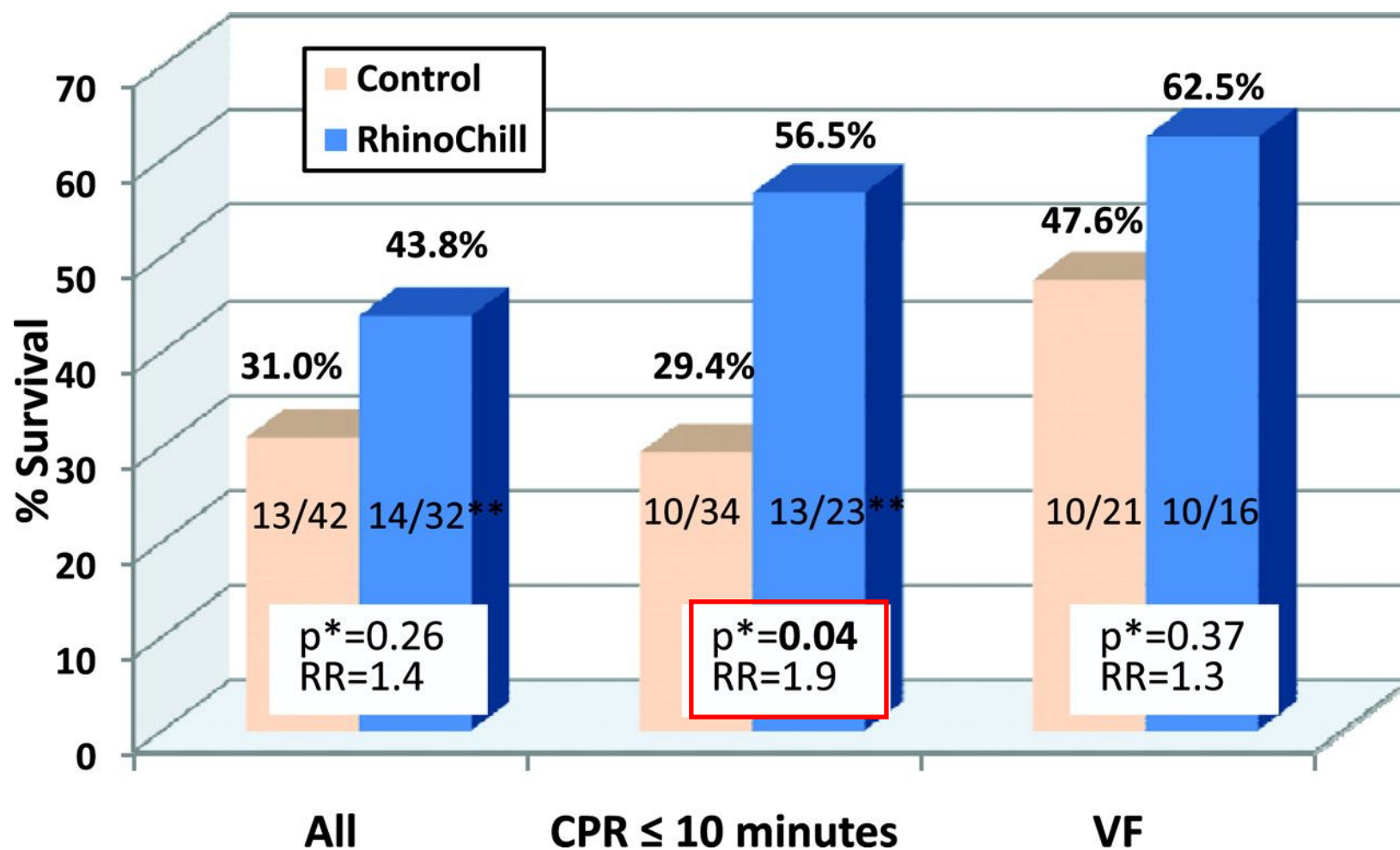
快速降低患者头部体温



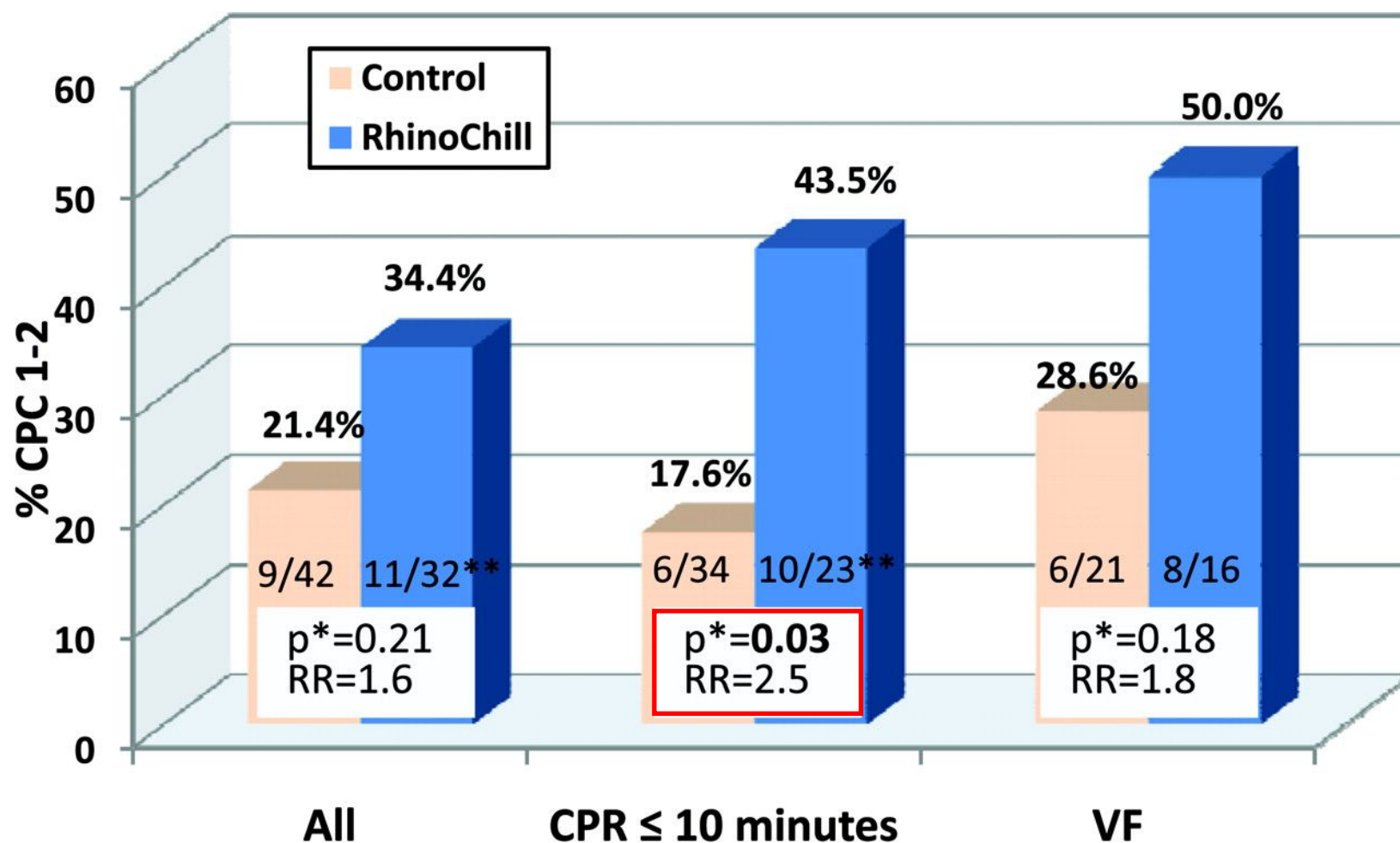
快速降低患者核心体温至目标温度



提高早期接受心肺复苏患者生存预后



提高早期接受心肺复苏患者神经功能预后



Intra-Arrest Transnasal Evaporative Cooling A Randomized, Prehospital, Multicenter Study (PRINCE: Pre-ROSC IntraNasal Cooling Effectiveness)

Maaret Castrén, MD, PhD*; Per Nordberg, MD*; Leif Svensson, MD, PhD; Fabio Taccone, MD;

Background—Transnasal evaporative cooling has sufficient heat transfer capacity for effective intra-arrest cooling and improves survival in swine. The aim of this study was to determine the safety, feasibility, and cooling efficacy of prehospital transnasal cooling in humans and to explore its effects on neurologically intact survival to hospital discharge.

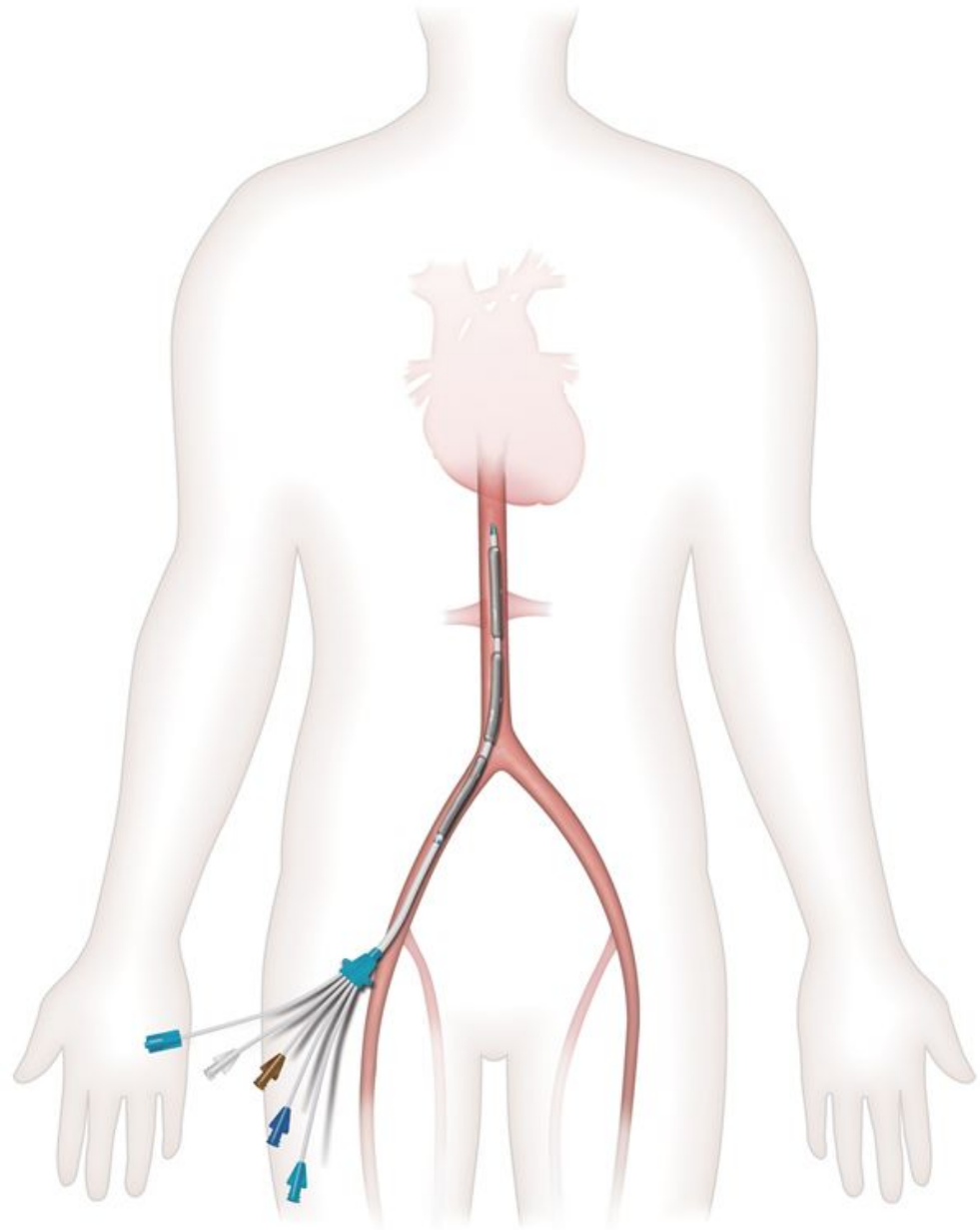
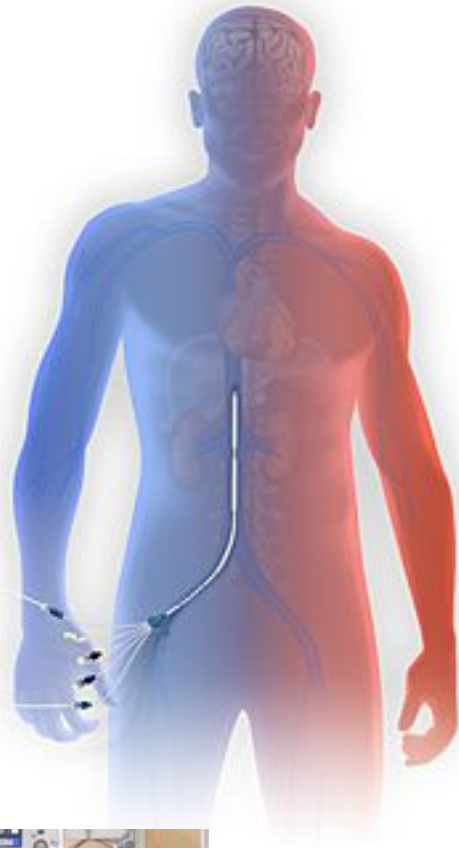
Methods and Results—Witnessed cardiac arrest patients with a treatment interval ≤ 20 minutes were randomized to intra-arrest cooling with a RhinoChill device (treatment group, $n=96$) versus standard care (control group, $n=104$). The final analysis included 93 versus 101 patients, respectively. Both groups were cooled after hospital arrival. The patients had similar demographics, initial rhythms, rates of bystander cardiopulmonary resuscitation, and intervals to cardiopulmonary resuscitation and arrival of advanced life support personnel. Eighteen device-related adverse events (1 periorbital emphysema, 3 epistaxis, 1 perioral bleed, and 13 nasal discolorations) were reported. Time to target temperature of 34°C was shorter in the treatment group for both tympanic (102 versus 282 minutes, $P=0.03$) and core (155 versus 284 minutes, $P=0.13$) temperature. There were no significant differences in rates of return of spontaneous circulation between the groups (38% in treated subjects versus 43% in control subjects, $P=0.48$), in overall survival of those admitted alive (44% versus 31%, respectively, $P=0.26$), or in neurologically intact survival to discharge (Pittsburgh cerebral performance category scale 1 to 2, 34% versus 21%, $P=0.21$), although the study was not adequately powered to detect changes in these outcomes.

Conclusions—Prehospital intra-arrest transnasal cooling is safe and feasible and is associated with a significant improvement in the time intervals required to cool patients.

SUMMARY

小 结

- 治疗性亚低温应用的时机选择
- 选择性头部亚低温的临床应用前景
- 治疗性亚低温的治疗方案
- 治疗性低温今后的发展方向





Thank you
for your attention