Journal Meeting

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Therapeutic hypothermia for out-of-hospital cardiac arrest

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History of TH

- Napoleon's Russian campaign in 1812 to preserve injured limbs.
- 1945 : positive effects of TH for patient with severe head injury
- 1950 : positive effects of mild TH after brain ischemia and traumatic brain injury (dog)
- 1991: hypothermia induced after cardiac arrest → improvements in neurologic outcomes.(dog)
- 2002: two land mark human studies…..

	European study		Australian study	
Patient number	275		72	
Indication	ROSC from VF		ROSC from VF	
Temp. /duration	32 ~ 34 oC for 24hrs		33 oC for 12hrs	
Definition of outcome	Primary: CPC at 6 months Secondary: mortality at 6 months		Place of discharge: 1.Home, rehabilitation facility → good 2.long-term-care nursing facility or death → poor	
	hypothermia	normal	hypothermia	Normal
Good outcome	55%	39%	49%	26% (p=0.04)
mortality	41%	55%	51%	68% (p=0.145)
Number need to treat	6			

AHA and ILCOR recommendation

- Patient was ROSC from OHCA with initial rhythm of VF → be cooled to 32 ~ 34 oC for 12 ~ 24hrs (Gr IIa)
- Similar therapy may also be beneficial for other rhythms (PEA, asystole) or inhospital cardiac arrest (Gr IIb).

Mechanism of action of TH

1. slowing of cellular metabolism
   - ↓1 ˚C → cellular metabolism slows by 6–8%→ decreasing demand for oxygen and glucose
2. cell membrane stability during oxygen deprivation
   - 缺氧減少ATP生成→Na-K ATP pump and Ca channels dysfunction → cellular apoptosis
3. Prevent reperfusion injury of brain
   - 避免ischemia產生的proinflammatory mediators 到腦部

Benefits of hypothermia

- ↓1 ˚C → ↓ 7% cardiac output
  - HR: 先快 (adrenergic stimulation) → progressive bradycardia (< 35 ˚C)
  - Vasoconstriction
- Hypothermia reduces ICP in patients with traumatic brain injury
- suppression of epileptic activity

Optimum ranges of hypothermia

- Hypothermia is divided into three categories:
  - mild (33–35 ˚C),
  - moderate (28–32 ˚C)
  - Severe (<28 ˚C)
- temperatures < 32 ˚C is associated with an increased risk of ventricular arrhythmias

Cooling methods - I

- Surface cooling: non-invasive
  - Generalized cooling
    - Cooling blanket, ice packs or cooling pad
    - 降溫慢(0.03 ~ 0.98oC/hr)
    - 溫度差異大(皮膚血管收縮、顫抖產熱、血液重新分布)
    - Overcooling
  - Selective brain cooling
    - Cooling helmet
    - 降溫慢

Cooling methods - II

- Invasive cooling:
  - IV 4 ˚C fluid → 0.8 ~ 1.2 ˚C
    - 30~40ml/kg or 2L over 30~60 mins
    - Contraindication: pulmonary edema or CRI requiring dialysis
    - 但有些研究顯示IV 2L 4 ˚C N/S並不會pulmonary edema
  - Endovascular cooling: a balloon catheter is inserted into the femoral vein and cools the patient's blood
    - 溫度調控精準，可降溫可升溫

Rewarming

- Most deaths caused by hypothermia occur during the rewarming phase.
  - ↑ cytokine, hypotension, ↑ ICP, ↓ CPP
- Rate: 0.5–1 ˚C/hr, about 8hrs
- Paralysis and sedation should be maintained until the patient's temperature reaches 35 ˚C

Monitoring temperature

- A true core temperature is that of the blood obtained from a pulmonary artery catheter.
- clinicians must be mindful of the delay between registered temperature and core temperature.
  - The faster the cooling rate, the greater the delay.

Complication - I

- Arrhythmia
  - less responsive to many antiarrhythmic drugs and more difficult to defibrillate
  - prophylactic therapy: lidocaine may be preferable to amiodarone
- Hyperglycemia and hypoglycemia
  - Hypothermia → hyperglycemia
  - Rewarming → hypoglycemia

Complication - II

- Bleeding: ↓ 1 ˚C → coagulation-factor function is decreased by 10%
  - Transfusion with platelet or FFP
- Infection:
  - neutrophil and macrophage activities are inhibited at temperatures below 35 ˚C
  - Pulmonary and wound infections

Complication - III

- Fluid and electrolyte disturbance:
  - Mg2+ : prevent neurologic damage
  - K: 低溫時需補充
- Shivering:
  - Shivering response increase metabolic heat production by up to 600% from baseline
  - 建議使用neuromuscular blocker