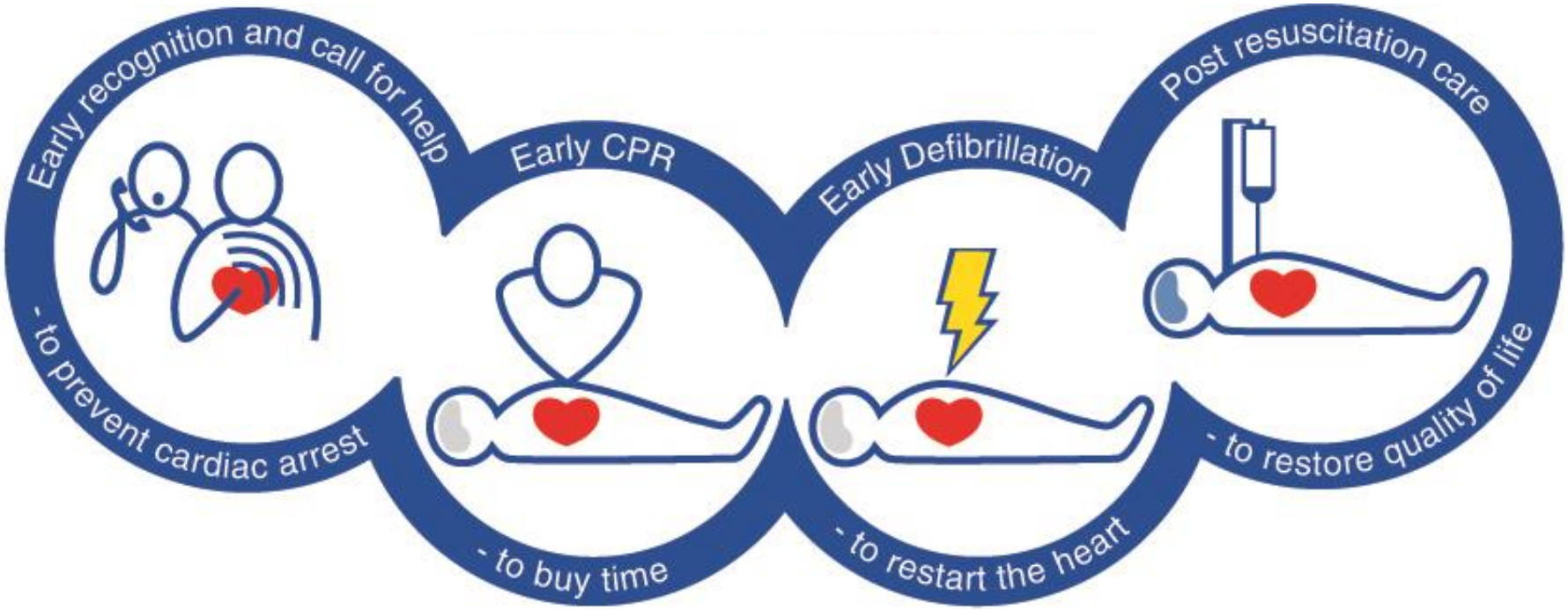
Post Cardiac Arrest Patient in the ICU



Jerry Nolan
Royal United Hospital
Bath

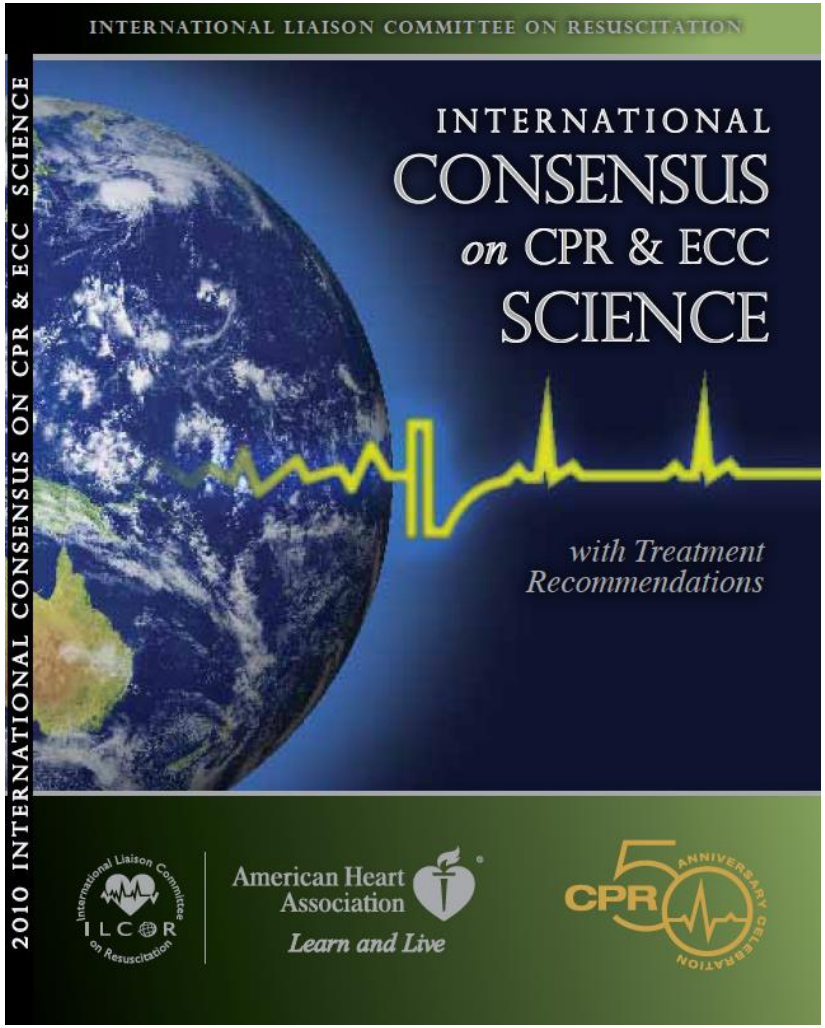
North East Intensive Care Society
Spring Meeting
23 March 2010


EAT
MOR
CHIKIN

Post cardiac arrest patient in ICU

- Outcome after admission to ITU
- The post cardiac arrest syndrome
- Cardiovascular support
- Neurological support
- Prognostication

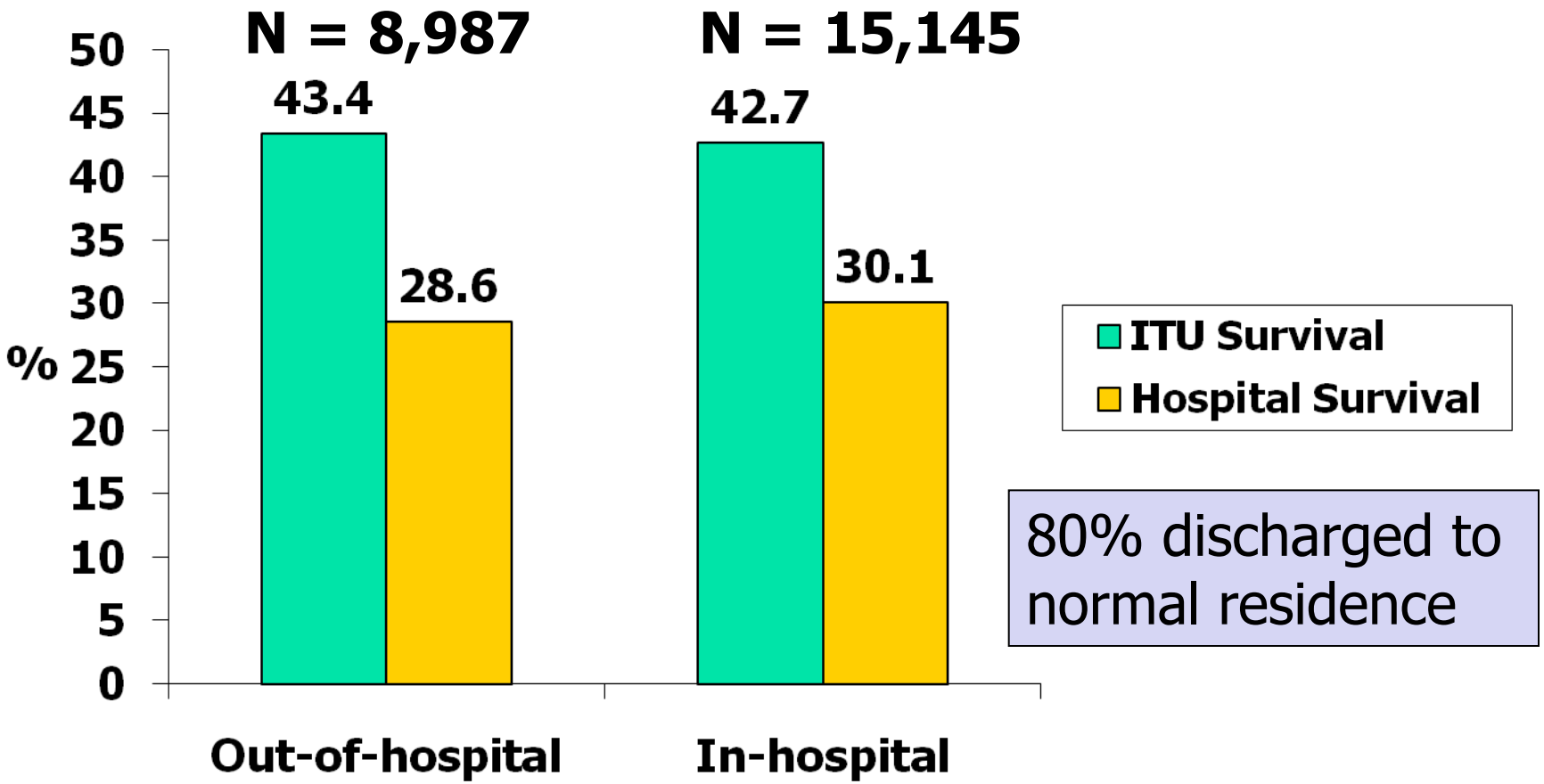
2010 International Consensus Conference on CPR Science



- ILCOR Consensus Conference 1-4 Feb 2010
- 450 evidence-based reviews
- Treatment recommendations based on science
- New AHA, ERC and RC (UK) guidelines online 18/10/10

www.ilcor.org

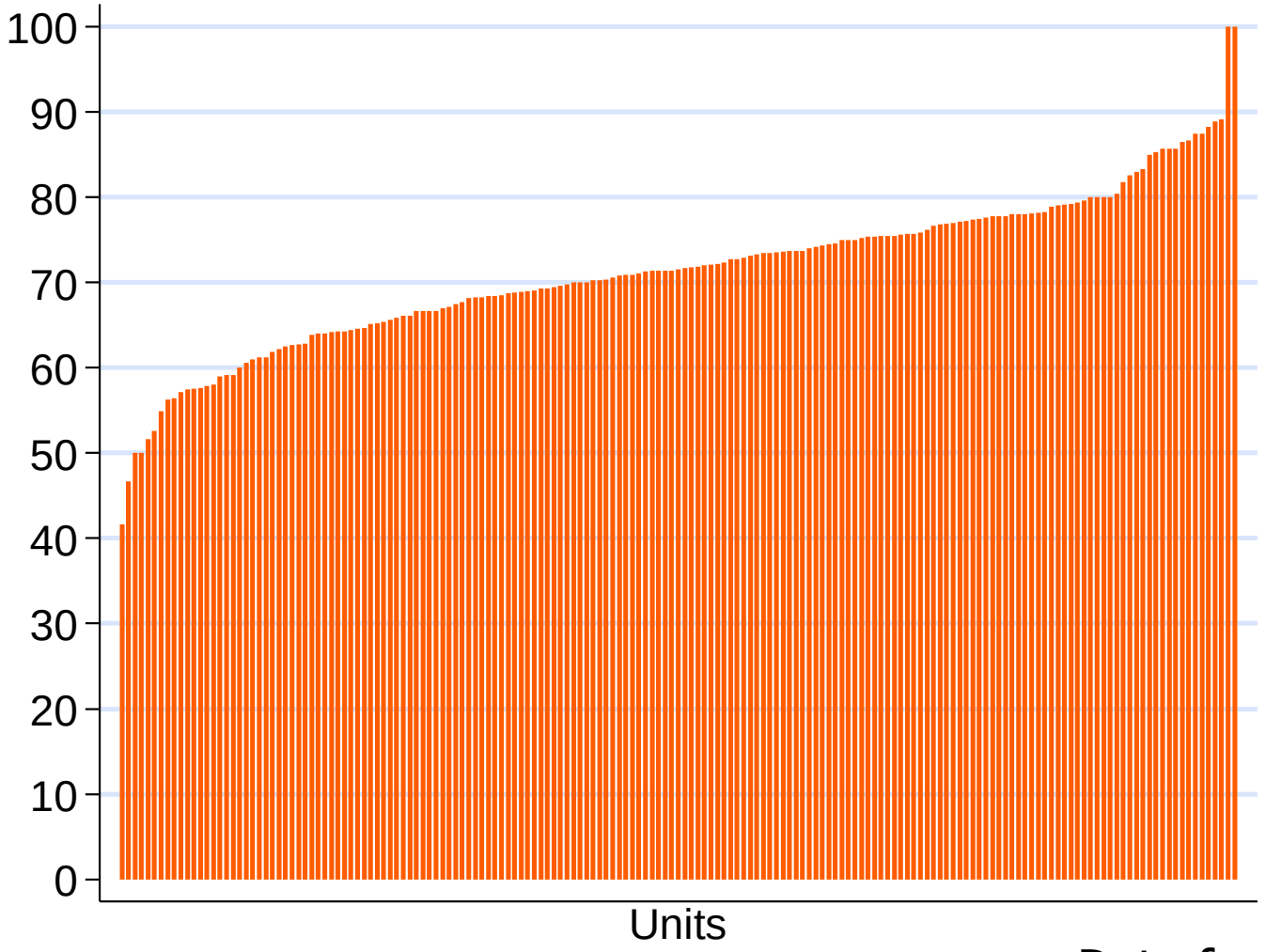
Outcome for cardiac arrest survivors admitted to ITU in UK



ICNARC Dec 1995 – Nov 2005

Nolan J. Anaesthesia 2007;62:1207-16

Variation in acute hospital mortality – out-of-hospital arrest



Data from ICNARC

Standards for the Management of Patients After Cardiac Arrest

STANDARDS AND GUIDELINES

Resuscitation (2008) 79, 350–379

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/resuscitation

ILCOR CONSENSUS STATEMENT

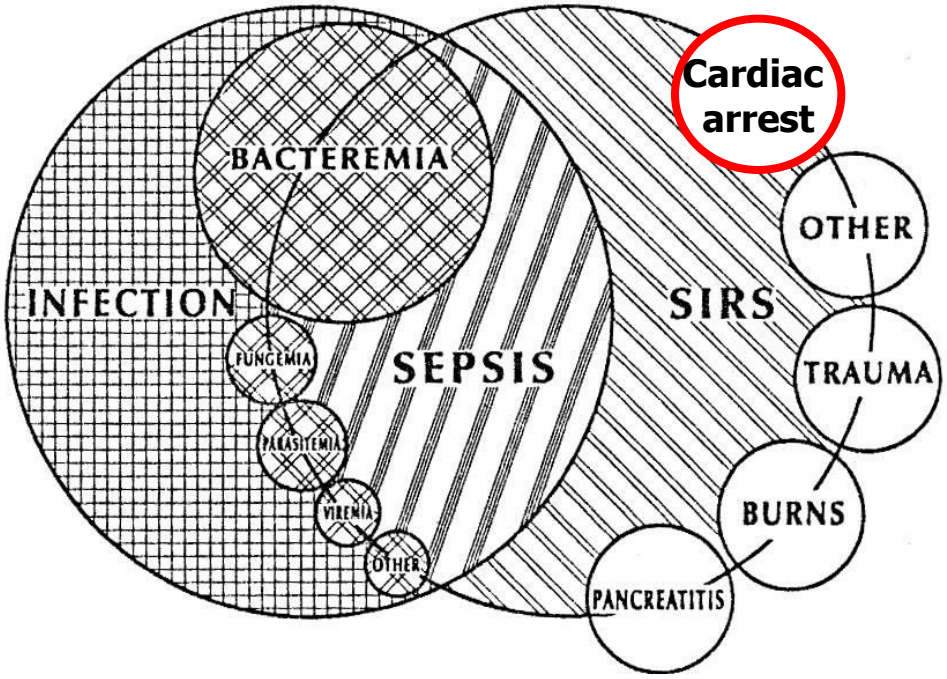
Post-cardiac arrest syndrome: Epidemiology, pathophysiology, treatment, and prognostication A Scientific Statement from the International Liaison Committee on Resuscitation;

Nolan JP, Neumar RW et al. Resuscitation 2008;79:350-79

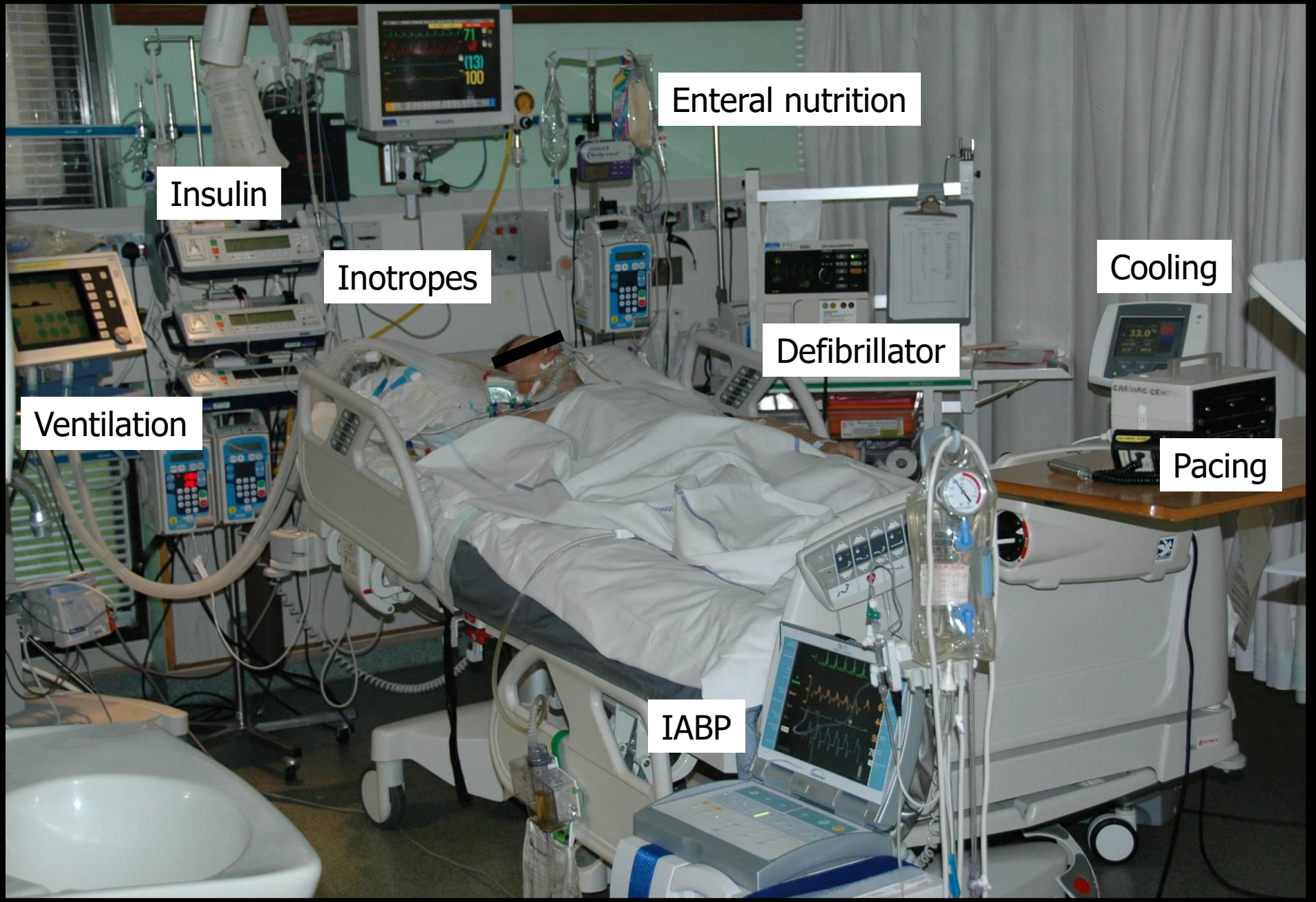
Post-cardiac arrest syndrome

1. Systemic ischaemia/reperfusion response
2. Persistent precipitating pathology
3. Post-cardiac myocardial dysfunction
4. Post-cardiac arrest brain injury

Inflammatory response after cardiac arrest

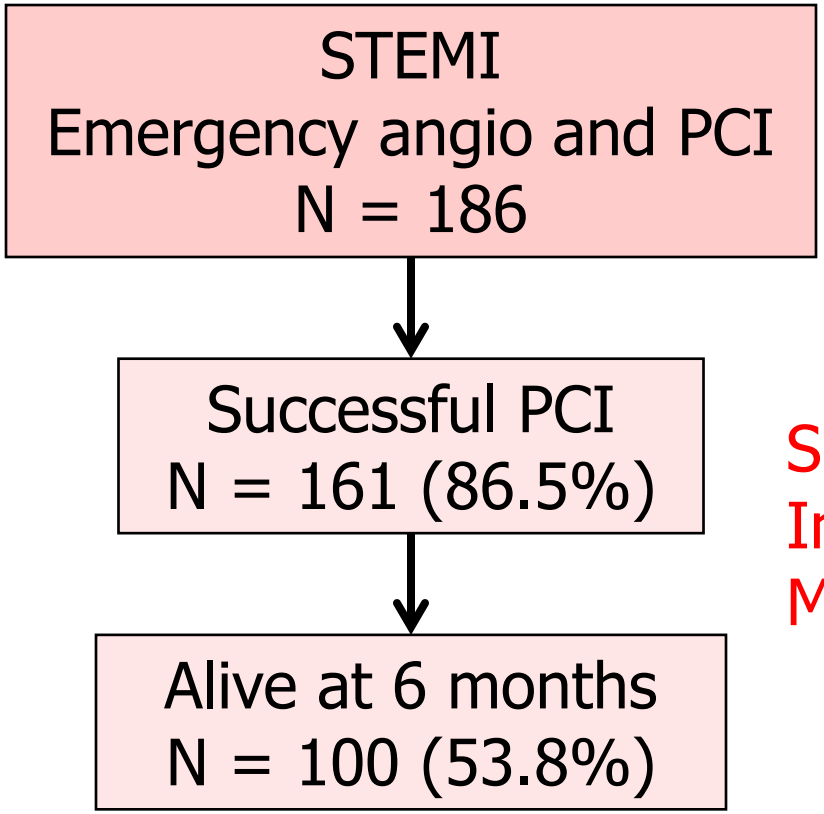


- High levels of IL-6, IL-8, IL-10, TNF
  - Adrie C. Circulation 2002;106:562-8
- Coagulation and fibrinolysis activated
  - Adrie C. JACC 2005;46:21-8.


Enteral nutrition
Insulin
Inotropes
Cooling
Defibrillator
Ventilation
Pacing
IABP

Early coronary reperfusion: PCI versus thrombolysis

Outcome of PCI after out-of-hospital cardiac arrest & STEMI



Data from 5 centres with high-volume PCI in France

Shock	96 (52%)
Intra-aortic balloon pump	80 (43%)
Mechanical ventilation	171 (92%)

Garot P. Circulation 2007;115:1354-62

Acute angiography after resuscitation from cardiac arrest

	STEMI	Not STEMI
Urgent angiography	192/192 (100%)	50/200 (25%)
Coronary disease	99%	78%
Culprit lesion	94%	36%
Urgent PCI	91%	32%
TIMI 3 Flow	81%	88%

Jan 2003 – Dec 2007
Ljubljana, Slovenia

Radsel P. Presented at ReSS 2008

Reversible myocardial dysfunction in survivors of out-of-hospital cardiac arrest

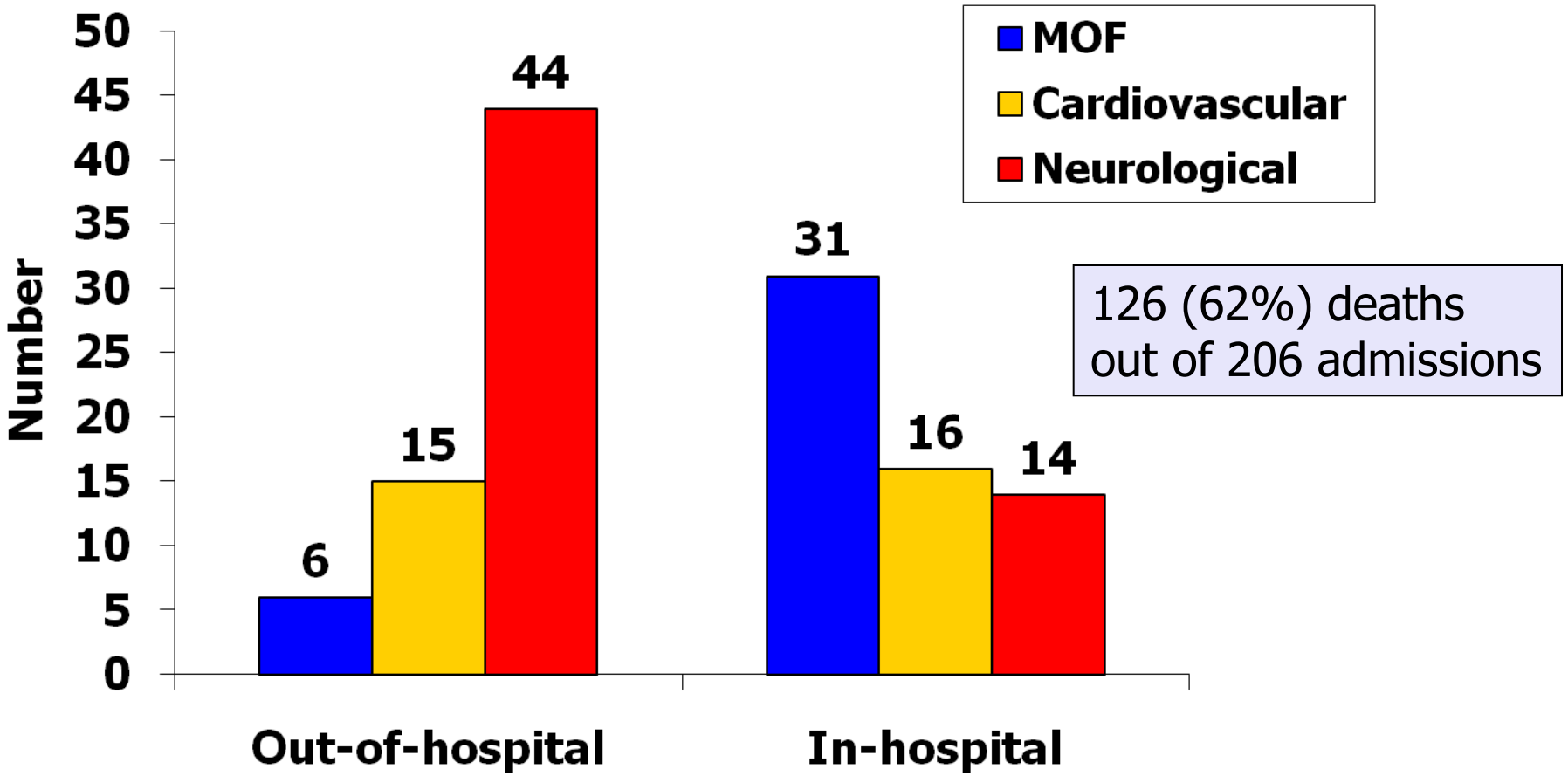
(n = 73)	8h	12 h	24 h	67 h
Adrenaline (mg h^{-1})	1.0	1.3	1.5	0.4
CI (l min^{-1} m^{-2})	2.05	2.61	3.19	3.69
SVRI	2,908	1,936	1,672	1,518
Temp (^oC)	36.6	37.3	37.6	37.8

Laurent I. J Am Coll Cardiol 2002;40:2110-6

Cardiovascular support

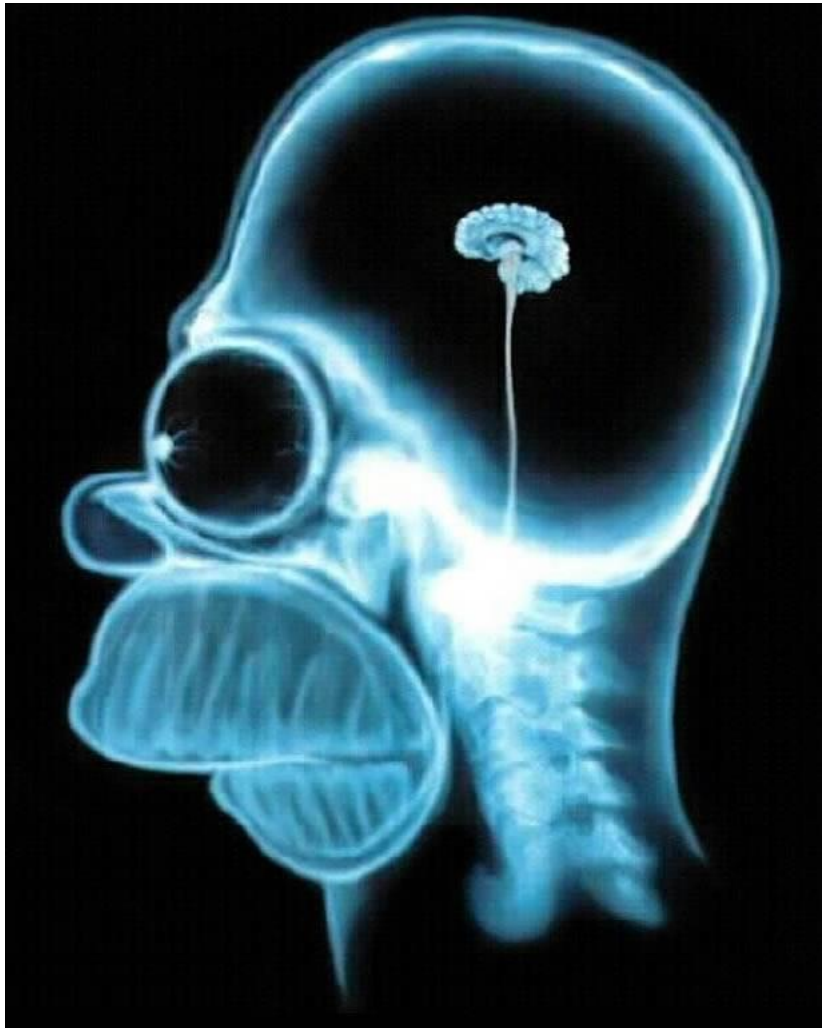
- Intra-aortic balloon pump
- Inotropes
  - Noradrenaline
  - Dobutamine
- Anti-arrhythmic therapy
- Pacing

Mode of death after admission to ITU following cardiac arrest



Laver S. Intensive Care Med 2004; 30:2126-8

Improving neurological outcome after cardiac arrest

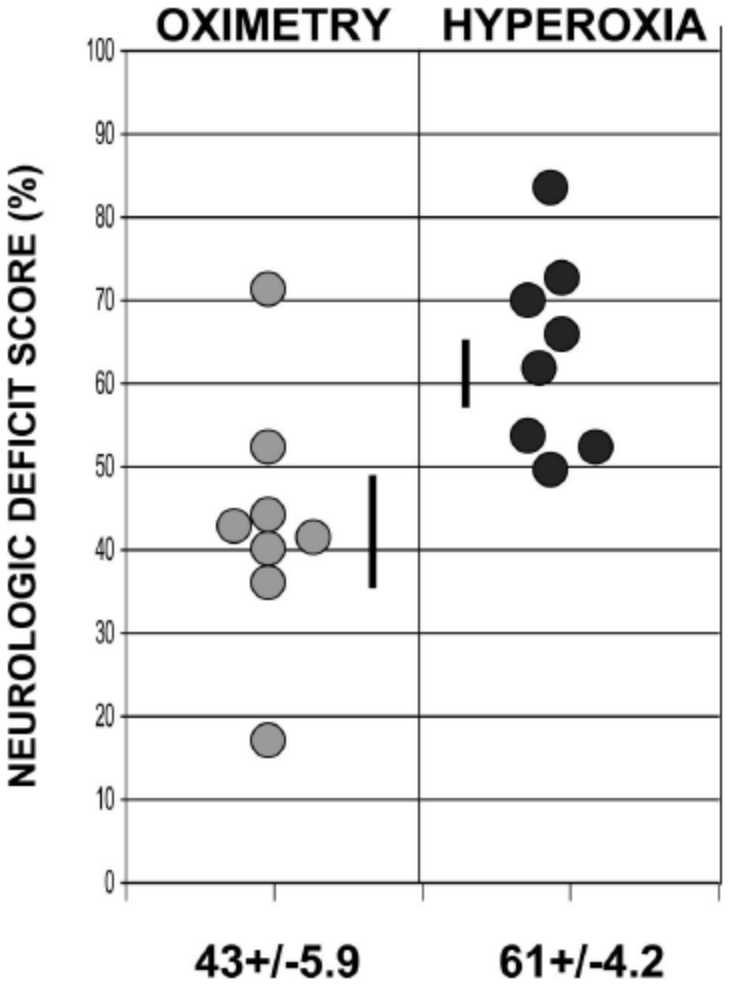


- Controlled re-oxygenation
- Cerebral perfusion
- Sedation
- Control of seizures
- Glucose control
- Temperature control

Hyperoxia after return of spontaneous circulation

- Hyperoxia during early reperfusion may harm postischaemic neurones
  - Vereczki V. J Cerebral Blood Flow Metab 2006;26:821-5
  - Richards EM. Stroke 2007; 38: 1578-84
  - Zwemer CF. Resuscitation 1994; 27: 159-70.
  - Liu Y. Stroke 1998;2 9: 1679-86.

Oximetry-guided re-oxygenation improves outcome after cardiac arrest



- 8 dogs per group
- 10 min cardiac arrest
- 1 hour ventilation:
  - 100% O_2 versus
  - SpO_2 94 – 96%

Balan IS. Stroke 2006; 37: 3008-13

Brain – cerebral perfusion

- Cerebral hyperaemia (initially), but rarely high ICP except asphyxial arrest
- Impaired autoregulation
  - Nishizawa H. Acta Anaesthesiol Scand 1996;40:1149-53.
- Maintain adequate cerebral perfusion pressure
- MAP 80-100 mmHg??
  - Bell DD. Can J Anaesth 2005;52:309-322

Brain – control of seizures

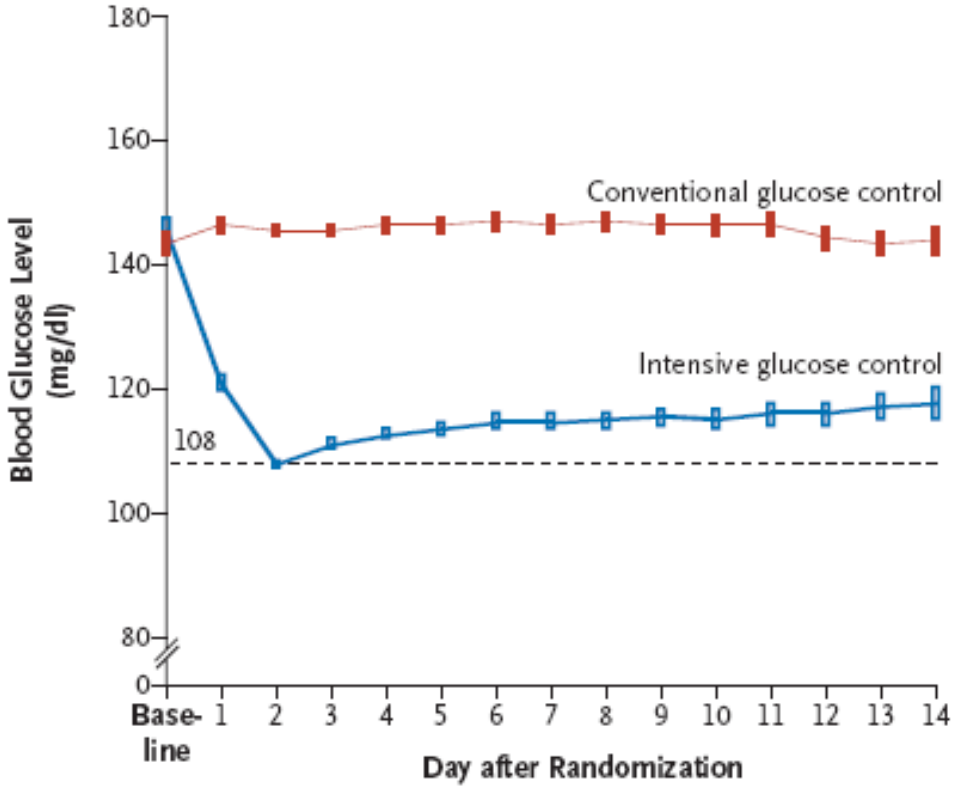
- Occur in 5-15% of those who achieve ROSC and in 40% of those remaining comatose
- Increase cerebral oxygen consumption
- Drugs
  - No data on the use of prophylactic anti-convulsants
- Monitoring; especially with NMBs?

Strict versus moderate glucose control after VF cardiac arrest

- Out-of-hospital VF cardiac arrest
- 90 patients – all cooled (intravascular)
- Insulin for 48 h; randomised:
  - Glucose 4 – 6 mmol l^{-1} (SGC)
  - Glucose 6 – 8 mmol l^{-1} (MGC)
- 30-day mortality and hypos (<3 mmol)
  - SGC 13/39 **(33%)** **18%**
  - MGC 18/51 **(35%)** **2%**

Oksanen S. Intensive Care Med 2007;33:2093-100

NICE-SUGAR Study



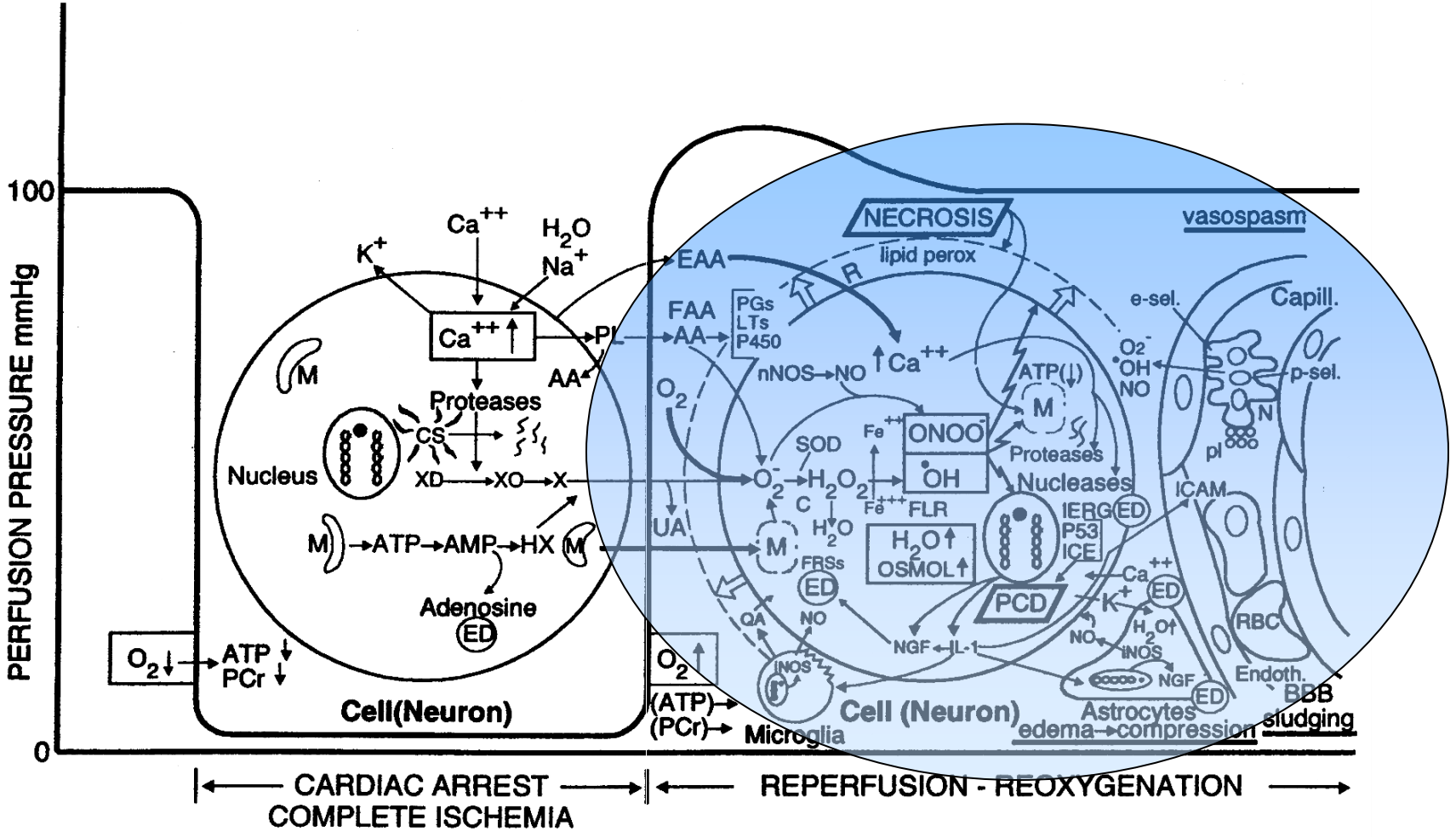
- 6104 patients predicted ICU stay > 3 days:
  - 4.5 – 6.0 mmol L^{-1}
  - < 10.0 mmol L^{-1}
- 90-day mortality
  - Intensive 27.5%
  - Conventional 24.9%
  - P = 0.02

N Engl J Med 2009;360:1283-97

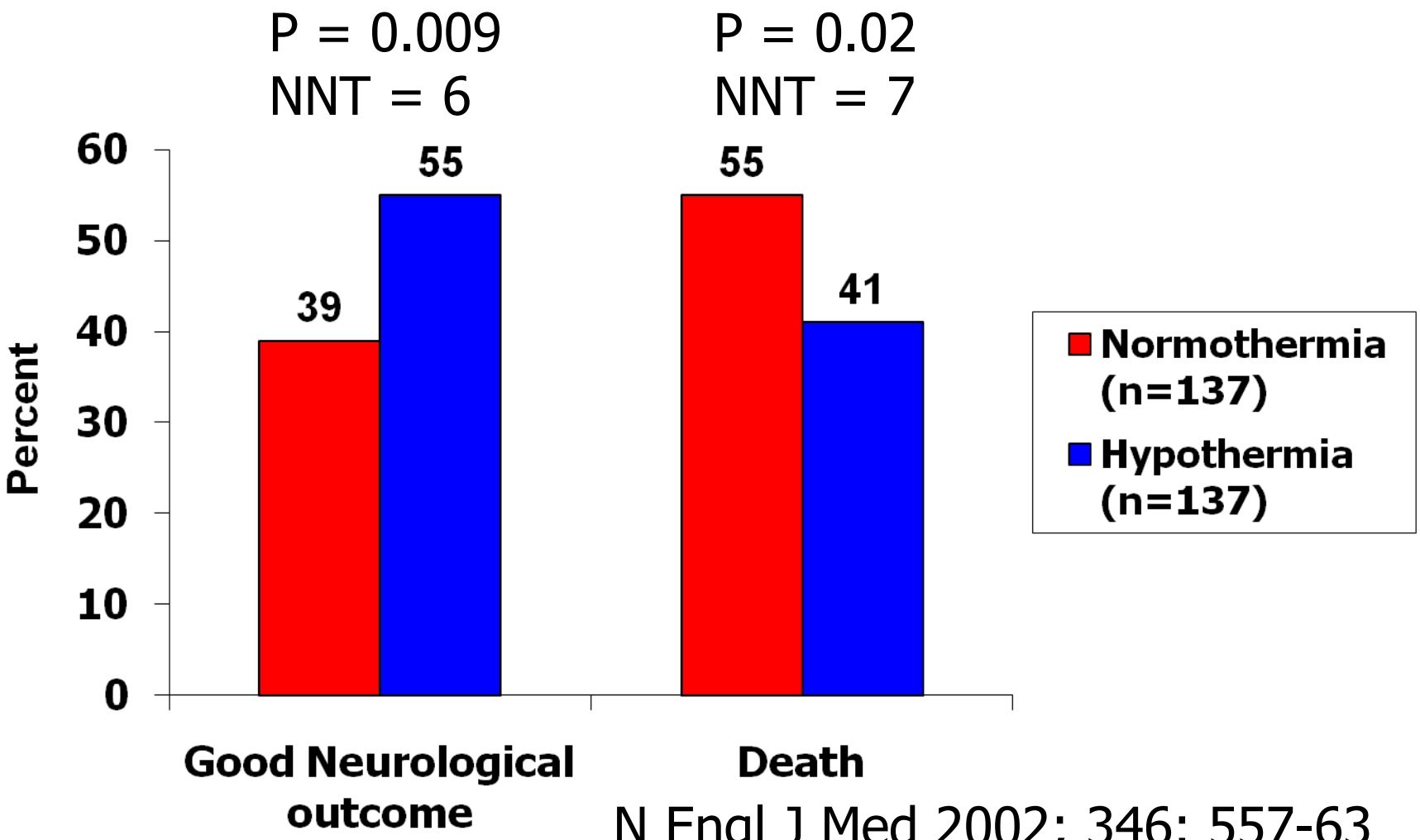
Brain – temperature control

- Prevention of hyperthermia
  - Hyperthermia common for 2-3 days
    - Takino M. Intensive Care Med 1991;17:419-20
  - Hyperthermia associated with poor outcome
    - Zeiner A. Arch Intern Med 2001;161:2007-12
    - Hickey RW. Crit Care Med 2003;31:531-5
- Therapeutic hypothermia

Hypothermia: Mechanism of action?



The Hypothermia After Cardiac Arrest (HACA) Study Group



N Engl J Med 2002; 346: 557-63

Therapeutic hypothermia after cardiac arrest

An Advisory Statement by the ALS Task Force of the International Liaison Committee on Resuscitation (ILCOR)

- Unconscious adult patients with spontaneous circulation after out of hospital cardiac arrest should be cooled to 32-34°C for 12-24 hours when the initial rhythm was VF
- For any other rhythm, or cardiac arrest in hospital, such cooling may also be beneficial

Nolan J. Resuscitation 2003; 57:231-5

Cooling techniques

External

- Ice packs, wet linen, fans
- Cooling blankets
  - Air, e.g. Polar Air
  - Water, e.g. Blanketrol
- Pre-refridgerated cooling pads
- Hydrogel-coated pads
- Cold water immersion

Internal

- Cold i.v. saline
- Intravascular catheters
  - Intravascular balloons
  - Metal catheter
  - Helix system

Polderman KH. Crit Care Med 2009;37:1101-20

Start cooling with cold i.v. fluid

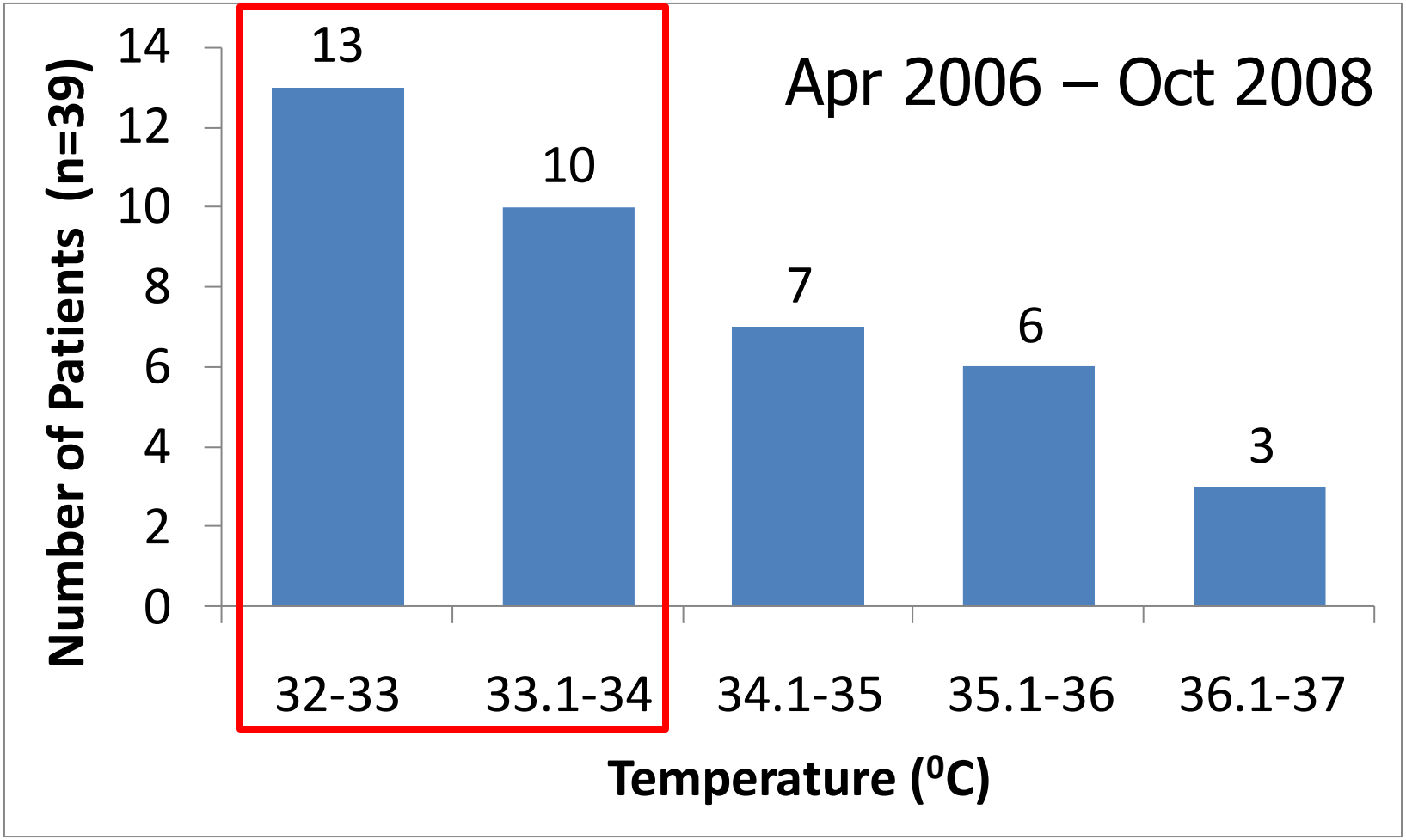
Cooling with ice-cold i.v. fluid

Study	N	T ^{o}C	Comments
Bernard S. Resuscitation 2003;56:9-13	22	1.7	30 ml kg^{-1} Hartmann's at 4^{o}C. No pulmonary oedema
Kliegel A. Resuscitation 2005;64:347	26	1.8	2 pts mild pulmonary oedema
Virkkunen I. Resuscitation 2004;62:299	13	1.8	Prehospital – 2 more trials underway
Kim F. Circulation 2007;115:3064-70	125	1.2	RCT prehospital – half given cold fluid. Pilot study
Bruel C. Crit Care 2008;12:R31	33	2.1	1 pt pulmonary oedema

RCT of prehospital cooling (n=1200) due to complete Nov 2011
ClinicalTrial.gov NCT00391469

Kim F. J Neurotrauma 2009;26:359-63

Out-of-hospital cardiac arrests: temp on admission to ITU



Patil S. Unpublished data

Does more rapid cooling improve outcome?

- 49 patients intravascularly cooled (78% OHCA; 84% VF/VT) **Wolff B. Int J Cardiol 2009;133:223-8**
  - Multivariate analysis: time to target temperature = OR 0.69 (0.51 – 0.98) for good outcome per hour
- Hypothermia network study of 986 cooled patients **Nielsen N. Acta Anaesthesiol Scand 2009;53:926-34**
  - Time to target, duration of cooling, target temp = no association with outcome

Prehospital cooling

Prehospital cooling versus emergency department cooling

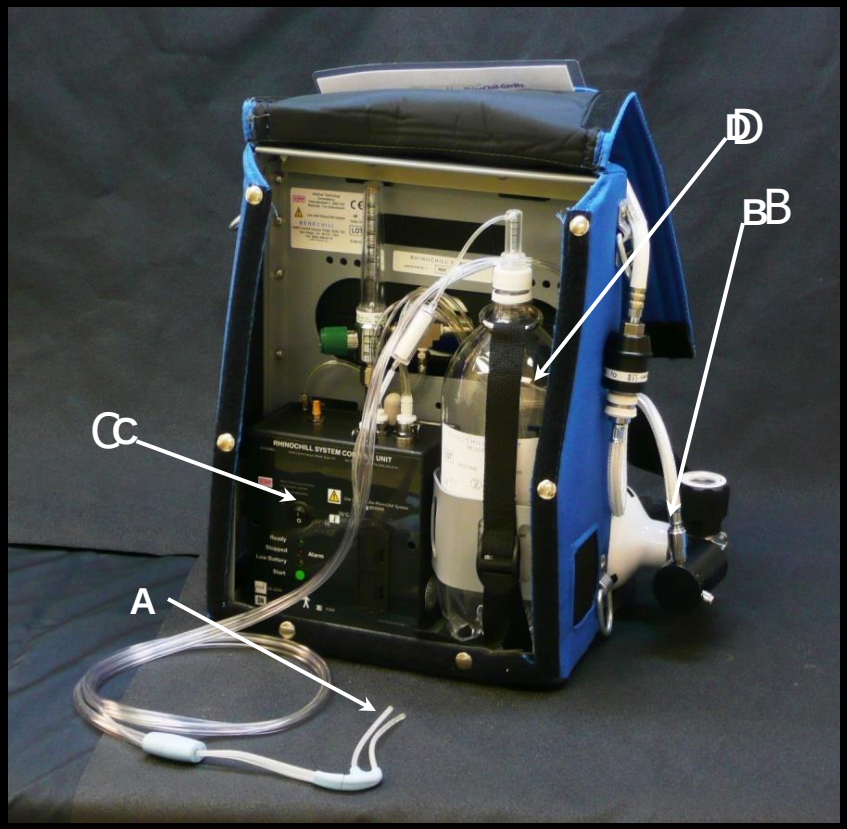
- VF cardiac arrest (n = 234)
- 2 litres cold saline prehospital vs. ED
- Temperature on ED arrival
  - Prehospital cooled 34.4°C
  - Control 35.9°C
- Survival to discharge
  - Prehospital cooled 48%
  - Control 51%

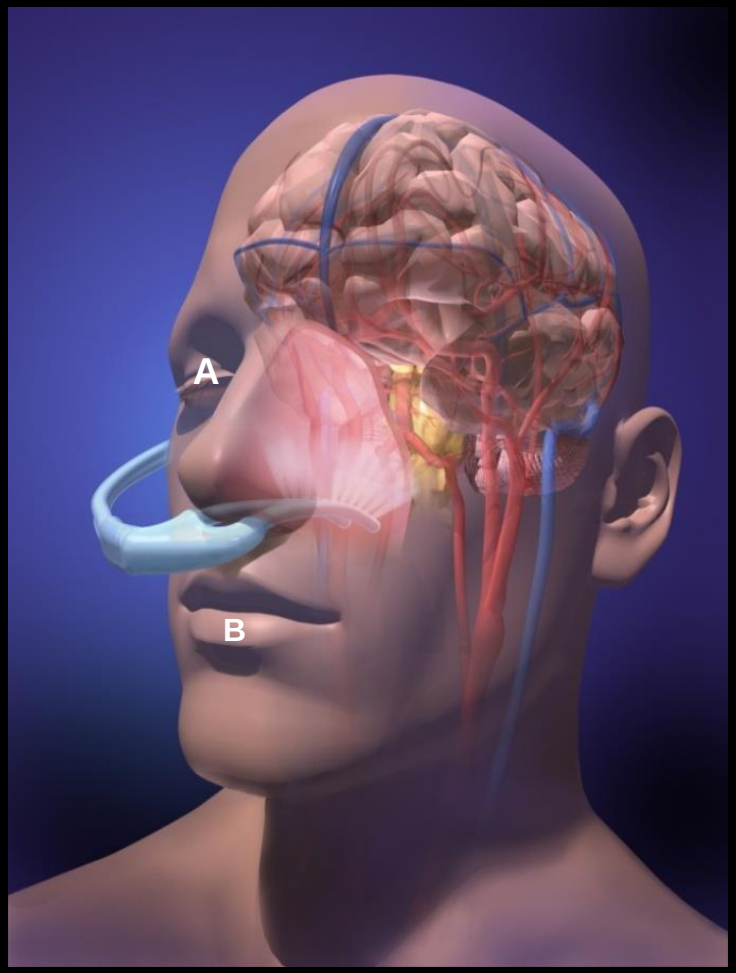
Bernard S. Presented at ReSS 2008

Cooling during CPR?

- Animal data indicate better outcomes
  - Kuboyama K. Crit Care Med 1991 & 1993
  - Nordmark J. Resuscitation 2005;66:357-65.
- Clinical 'pilot study' (n = 5)
  - Kamarainen A. Resuscitation 2008;76:360-3.
- Impact of fluid infusion during CPR??
- Cooling with cardiopulmonary bypass
  - Nagao K. Circ J 2010; 74: 77-85

RhinoChill™ intra-nasal cooling system





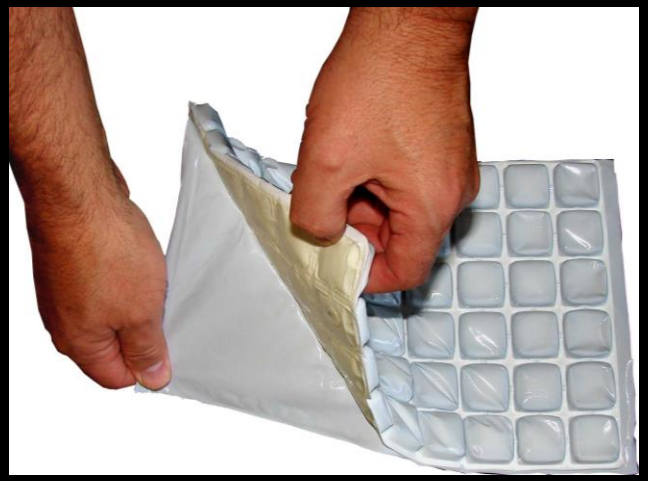
A: Nasal Catheter
B: Oxygen Tank
C: Control Unit
D: Coolant Bottle

External cooling

Larsson I-M. Resuscitation 2010;81:15-9

Laerdal MediCool

EMCOOLS



Uray T. Resuscitation 2008;77:331-8

Circulating cold water blankets

Water-circulating cooling device (Artic Sun®)

Heard KJ. Resuscitation 2010; 81: 9-14

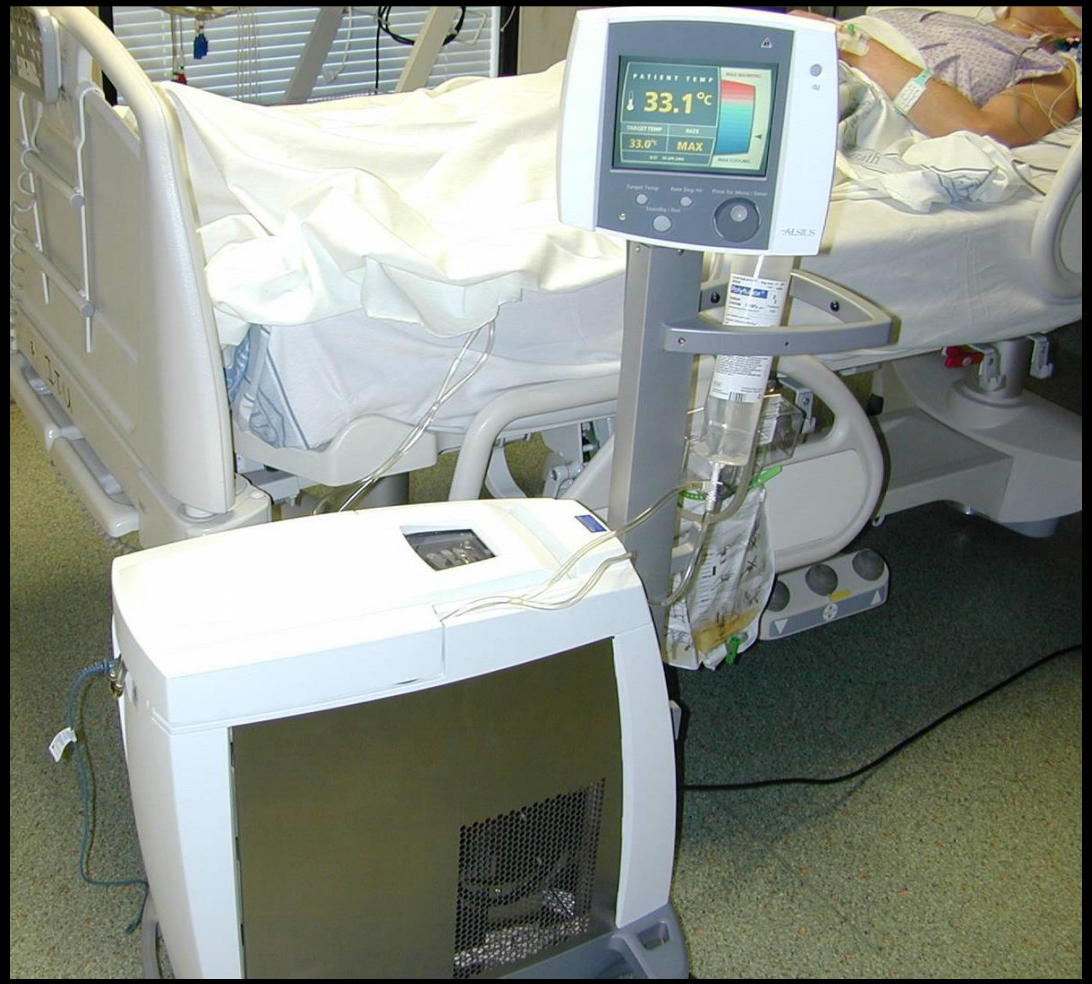
Convective-immersion surface cooling: ThermoSuit®

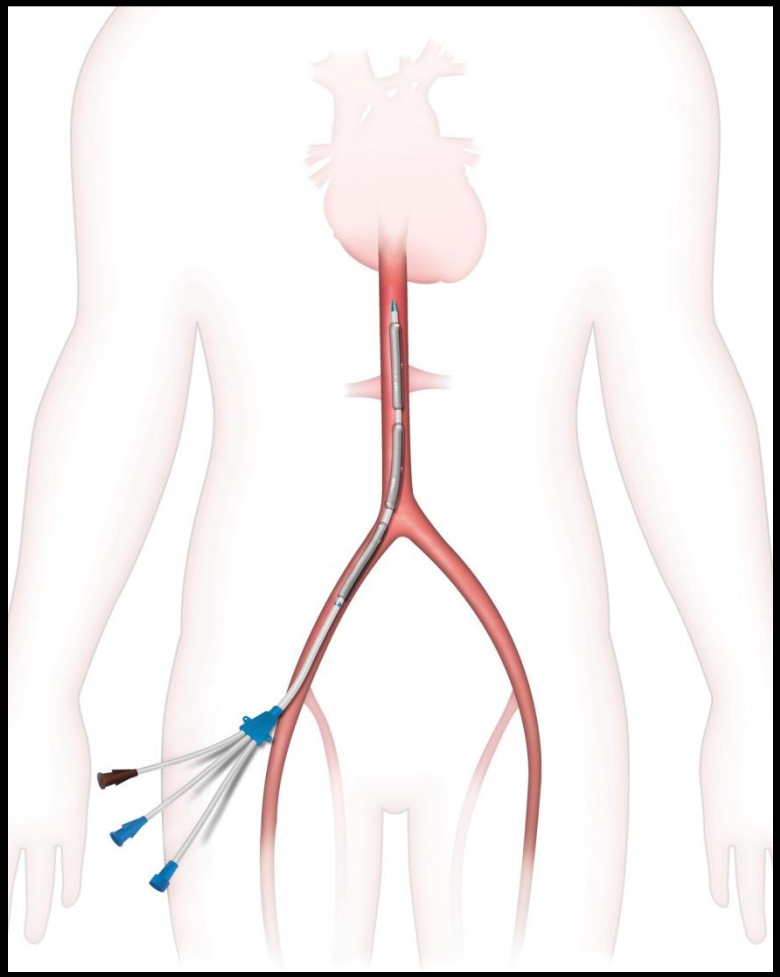
- 24 patients
- Median cooling rate = 3.0°C h^{-1}
- Faster with propofol
- Median time to < 34°C = 37 min

Howes D. Resuscitation 2010; 81: 388-92

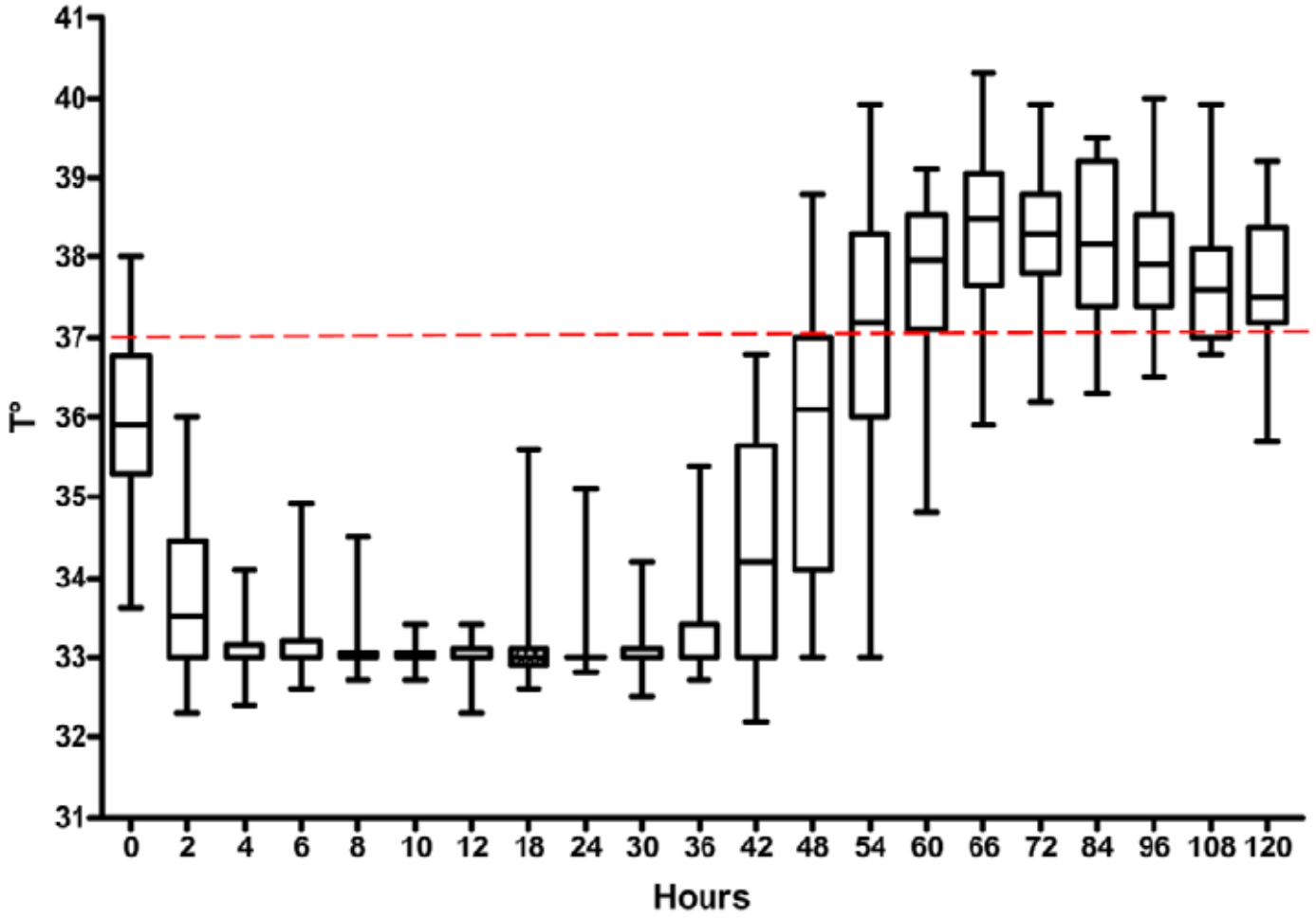

Photograph courtesy
of Dr M. Foedisch

Endovascular cooling



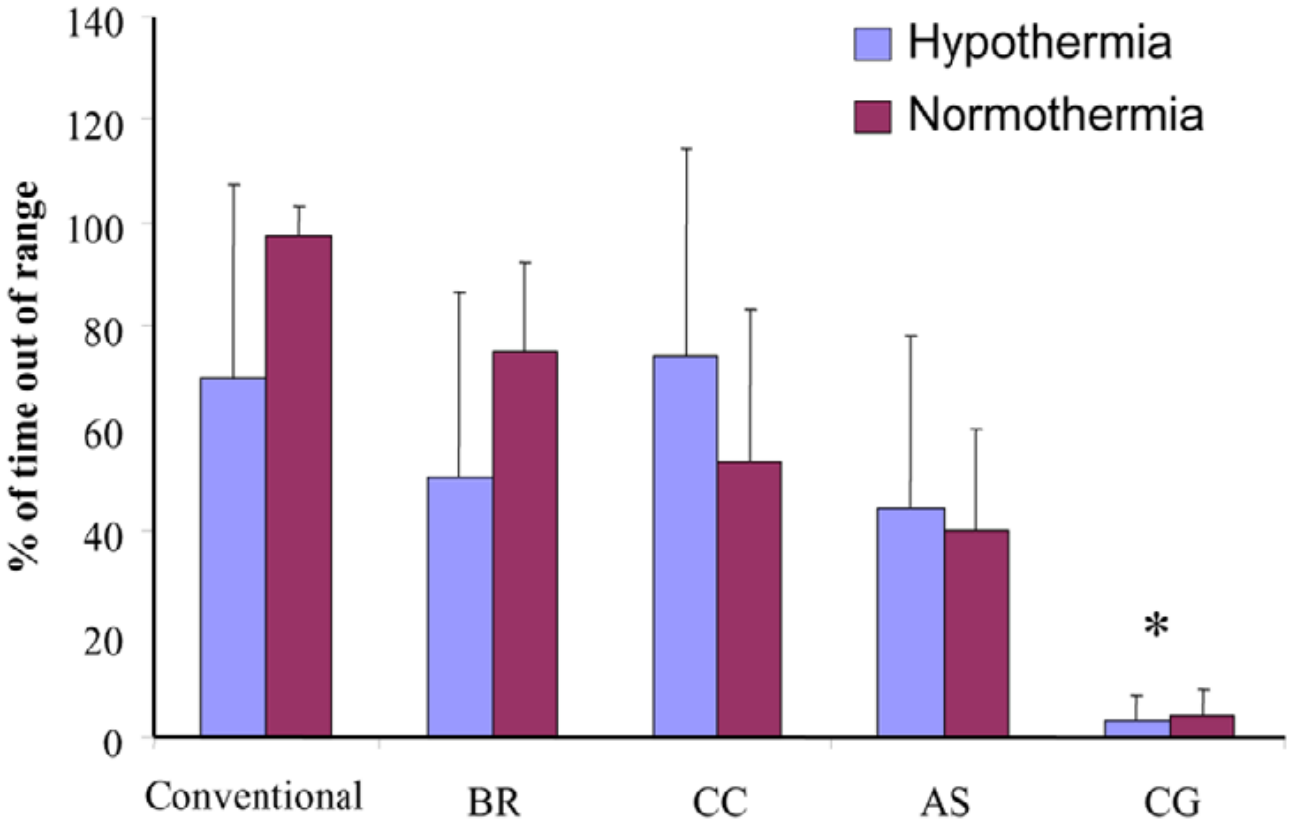


Intravascular cooling after OHCA France, n = 40



Pichon N. Crit Care 2007; 11: R71

Comparison of cooling methods: time out of range (n = 50)



BR – Blanketrol
CC – Coolcair
AS – Arctic Sun
CG - Coolguard

Hoedemaekers CW. Crit Care 2007; 11: R91

Endovascular versus external cooling for OHCA

- ICEREA Study - Paris
  - 1º outcome: CPC 1 or 2 at 28 days
  - Coolgard versus 'conventional cooling'
  - Finished recruiting Nov 2009 (400)
  - ClinicalTrials.gov NCT00392639

Duration of cooling?

- Optimal duration not defined
- Most centres using 24 h
- Optimal duration probably depends on:
  - time to ROSC
  - delay to target temperature
- Up to 72 h in some cases

Gunn AJ NeuroRx 2006;3:154-69

Shivering

- More common during cooling and rewarming phases
- Sedation: e.g., propofol/opioid
- Neuromuscular blocker (NMB) bolus
- Occasionally, NMB infusion (Bath -12%)
  - Need for continuous EEG monitoring?

Mahmood MA. J Neurol Sci 2007;261:47-54

Magnesium
(e.g., 5 g infused over 5 h)

- Increases rate of surface cooling
  - Zweifler RM. Stroke 2004; 35: 2331-4
- Reduces shivering threshold
  - Wadhwa A. BJA 2005; 94: 756-62.
- Neuroprotective when combined with hypothermia
  - Zhu H. Brain Research 2004; 1014: 53-60.
- Anti-arrhythmic

Clinical practice protocols

Resuscitation 80 (2009) 418–424

Contents lists available at ScienceDirect

RESUSCITATION

Acta Anaesthesiol Scand 2009; 53: 280–288
Printed in Singapore. All rights reserved

ACTA ANAESTHESIOLOGICA SCANDINAVICA
doi: 10.1111/j.1399-6576.2008.01881.x

Scandinavian Clinical practice guidelines for therapeutic hypothermia and post-resuscitation care after cardiac arrest

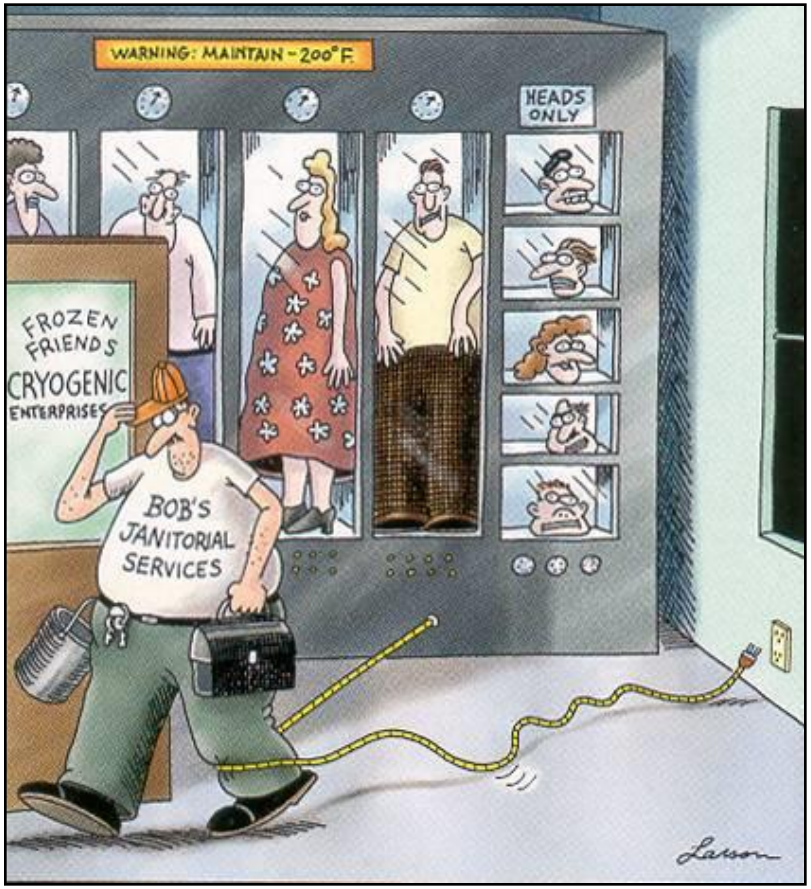
M. Castrén[1], T. Silfvast[2], S. Rubertsson[3], M. Niskanen[4], F. Valsson[5], M. Wanscher[6] and K. Sunde[7] (Task Force on Scandinavian Therapeutic Hypothermia Guidelines, Clinical Practice Committee Scandinavian Society of Anaesthesiology and Intensive care Medicine)

www.med.upenn.edu/resuscitation/hypothermia

Current practice in Bath

- Patients remaining comatose after cardiac arrest are cooled to 32-34^{o}C once decision made to admit to ITU
- 2 l ice-cold crystalloid over 30 min
- Maintain hypothermia with intravascular cooling for 24 h
- Rewarm at 0.25^{o}C h^{-1}
- Leave cooling catheter for 72 h (36.5^{o}C)

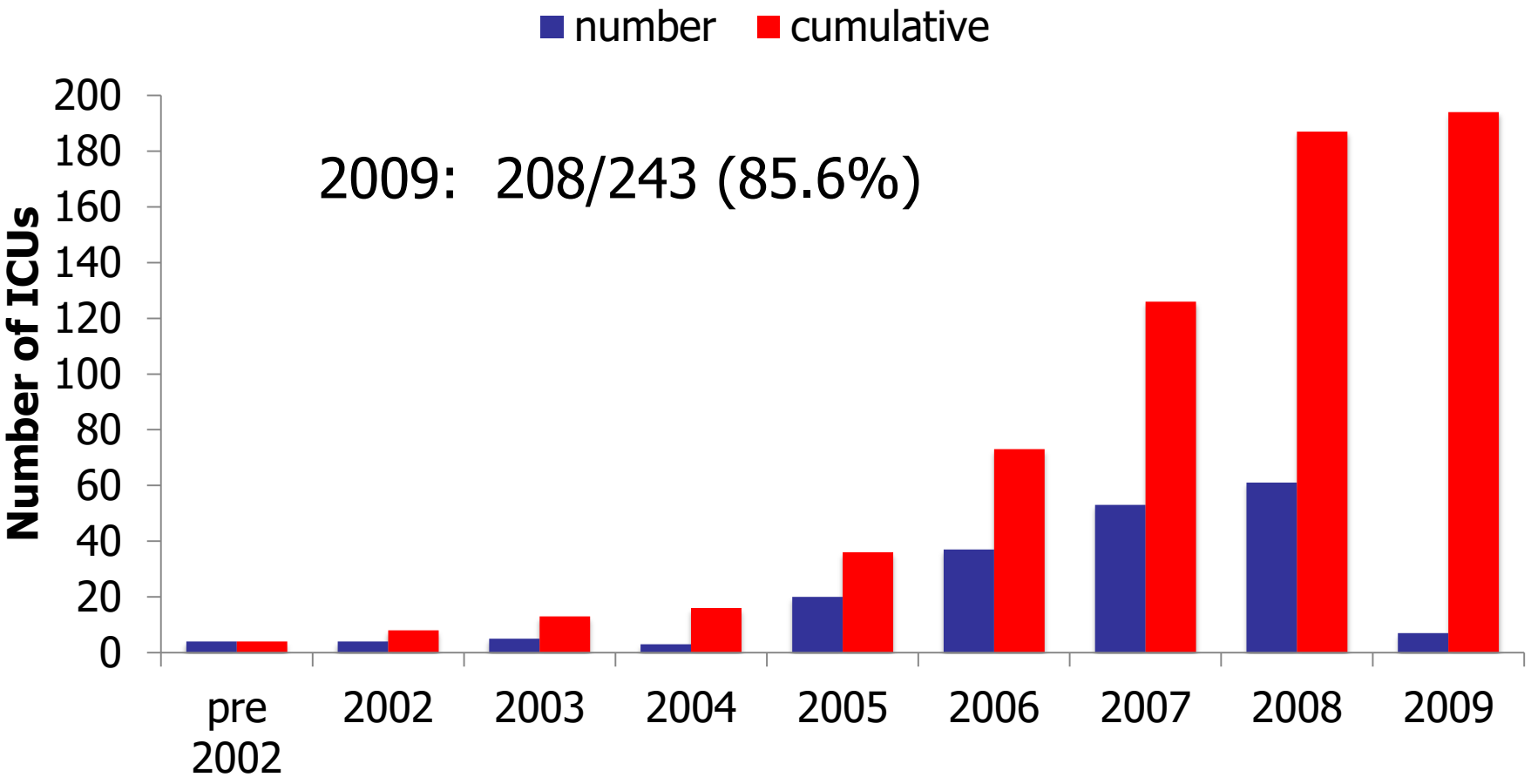
Therapeutic Hypothermia: Physiological effects / complications



- Shivering
- Vasoconstriction
- Bradycardia
- Infection, coagulopathy
- Diuresis - hypovolaemia
- ↓ K^+, ↓ Mg^+, ↓ Ca^{2+}
- ↓ Insulin sensitivity
- Impaired GI absorption

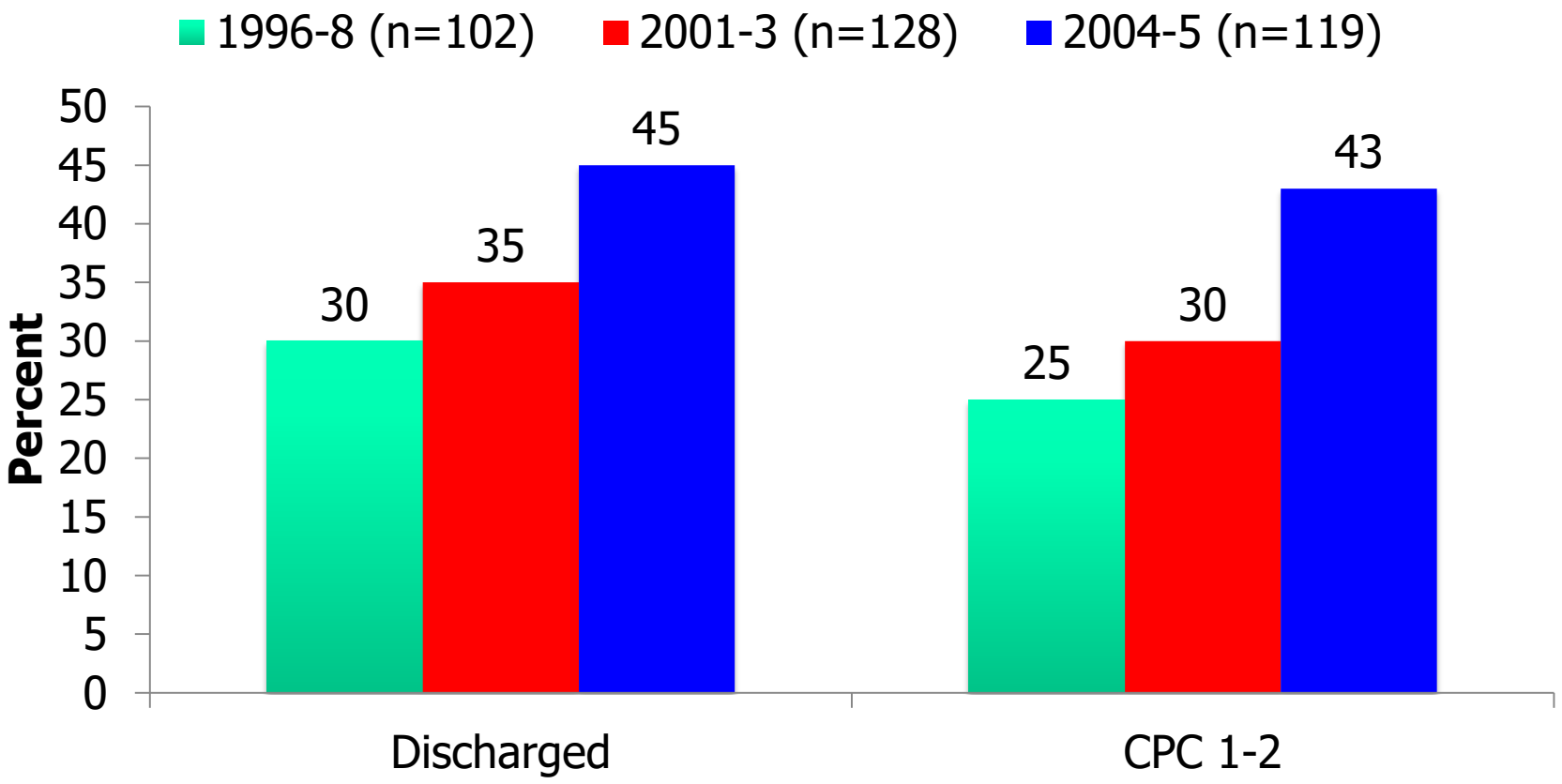
Polderman KH. Crit Care Med 2009;37:1101-20

Implementation of hypothermia in UK ICUs (by year)



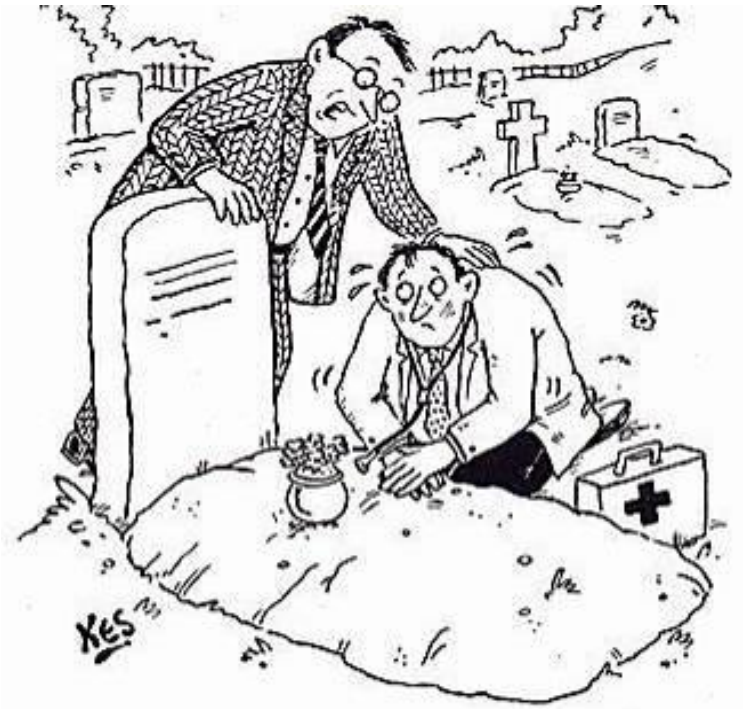
Binks A. Anaesthesia 2010;65:260-5

Survival after admission to ICU for OHCA – Oslo, Norway (All rhythms)



Lund-Kordahl I. Resuscitation 2010;81:422-6

Reliable clinical indicators of bad neurological outcome



"I admire your persistence doctor. But face it. You've lost this patient."

- Absent pupil **and** corneal reflexes at 3 days after cardiac arrest
- Absent or extensor motor reflexes at 3 days
- Myoclonic status epilepticus at any time
- Influence of hypothermia

Young GB. N Engl J Med 2009;361:605-11

Prognostication after cardiac arrest and hypothermia

Outcome at 3-6 months (n = 109)	CPC 1-2	CPC 3-5
Patients **n (%)**	25 (23)	84 (77)
ROSC > 25 min	6 (24)	46 (55)
≥ 1 brainstem reflex absent*	2 (8)	45 (54)
Motor response worse than flexion	4 (16)	64 (76)
Early myoclonus	1 (4)	35 (42)
Epileptiform activity on first EEG	3 (12)	36 (43)
Unreactive EEG background	0	56 (67)
Bilaterally absent N20 on SSEP	0	33 (46)

*pupillary, oculocephalic, corneal

Rossetti AO. Ann Neurol, in press

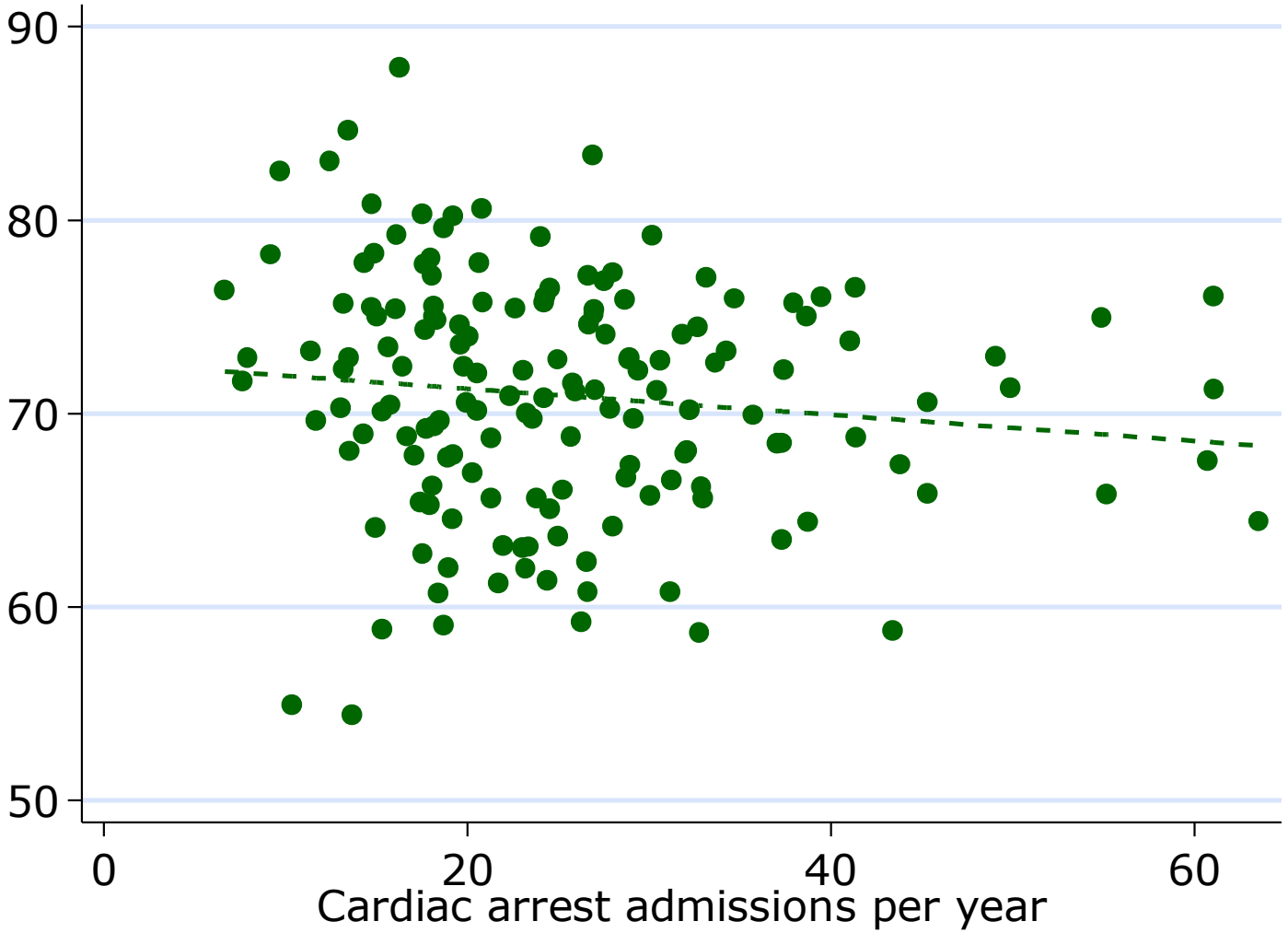
Regional Systems of Care for Out-of-Hospital Cardiac Arrest

A Policy Statement From the American Heart Association

- PCI 24 h, hypothermia, IABP, EEG and prognostication
  - Bobrow BJ. Curr Opin Crit Care 2009;15:221-7
- Transport interval after ROSC does not influence survival
  - Spaite DW. Ann Emerg Med 2009
- Outcome better with > 50 ICU cases/yr
  - Carr BG. Resuscitation 2009;80:30-4

Nichol G. Circulation 2010;121:709-29

Volume – outcome relationship? ICNARC data




CUT THE CRAP
AND SHOW US
the summary

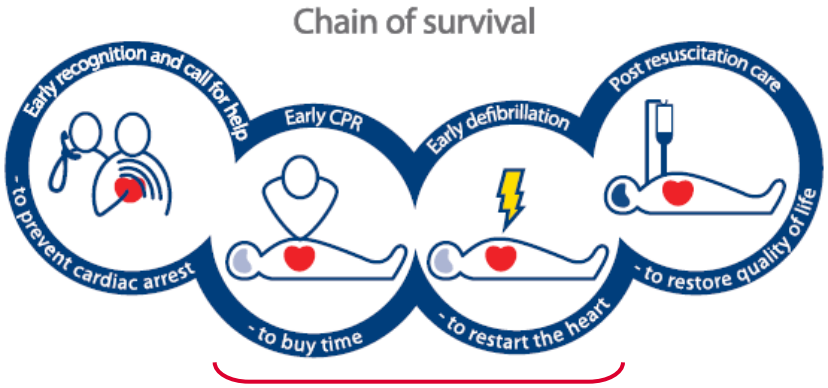
Post cardiac arrest patient in ICU Summary

- 30% survive to discharge in UK ITUs
- Post cardiac arrest syndrome
- Heart – early revascularisation, circulatory support
- Brain – hypothermia, glucose control?
- Prognostication - problematic


NEED CASH
FOR ALCOHOL
RESEARCH

National Cardiac Arrest Audit (NCAA)

- Secure, web-based data entry
- Validation, on data entry and centrally
- Online comparative reporting
- Initial scope- Individual receiving chest compressions and/or defibrillation from the hospital based resuscitation team (or equivalent)

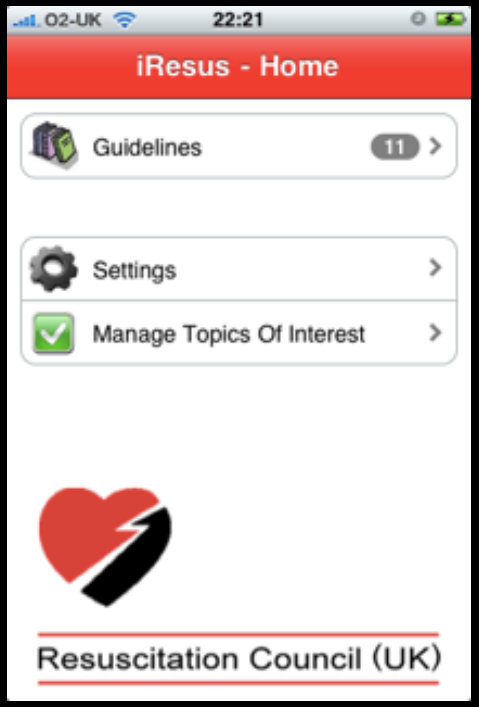


Small, modular dataset

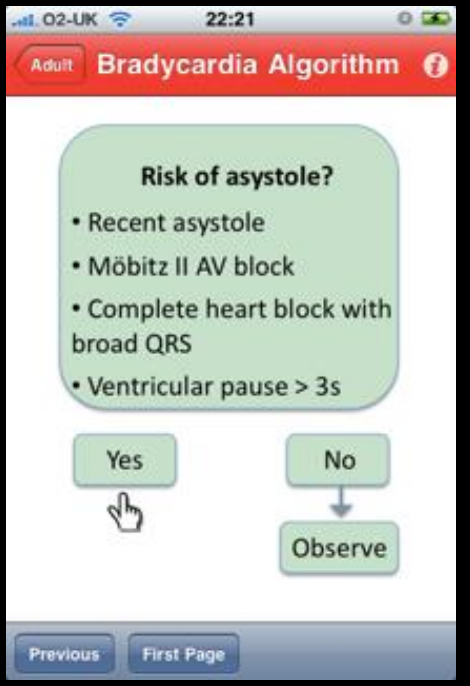
To take part, or to find out more about this audit, contact the NCAA team on ncaa@icnarc.org

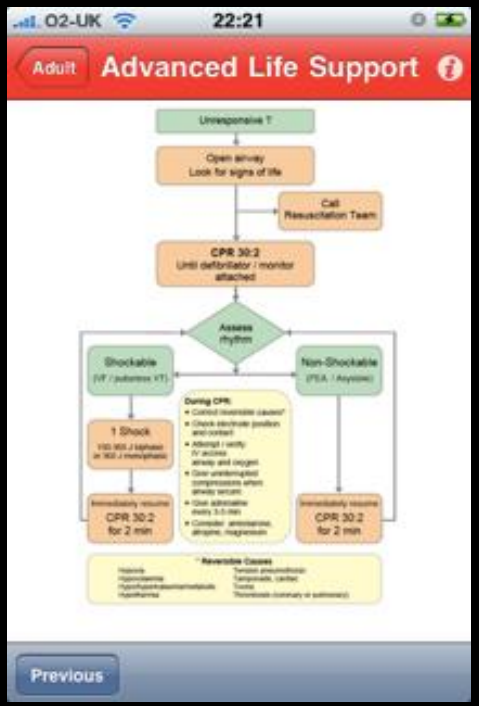
Supported by: Resuscitation Council (UK) and ICNARC

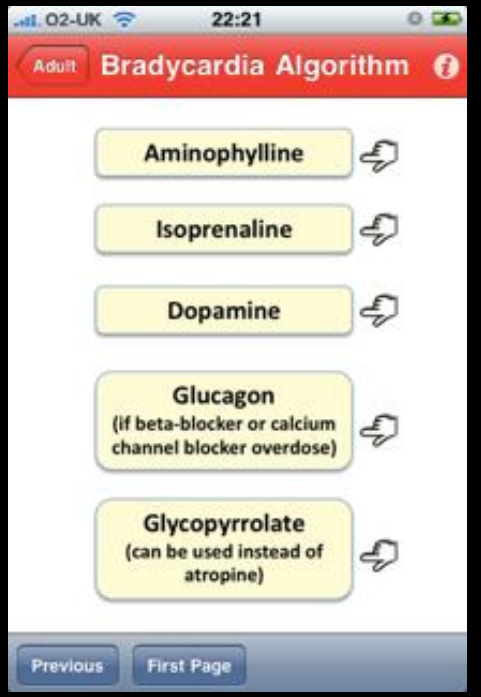
iResus


O2-UK 22:21
iResus - Home
Guidelines 11
Settings
Manage Topics Of Interest
Resuscitation Council (UK)


AT&T 3G 9:42 AM
Text
Calendar
Photos
Camera
YouTube
Stocks
Maps
Weather
Clock
Calculator
Notes
Settings
iTunes
App Store
Phone
Mail
Safari
iPod


O2-UK 22:21
Adult
Bradycardia Algorithm
Risk of asystole?
• Recent asystole
• Möbitz II AV block
• Complete heart block with broad QRS
• Ventricular pause > 3s
Yes
No
Observe
Previous
First Page


O2-UK 22:21
Adult
Advanced Life Support
Previous

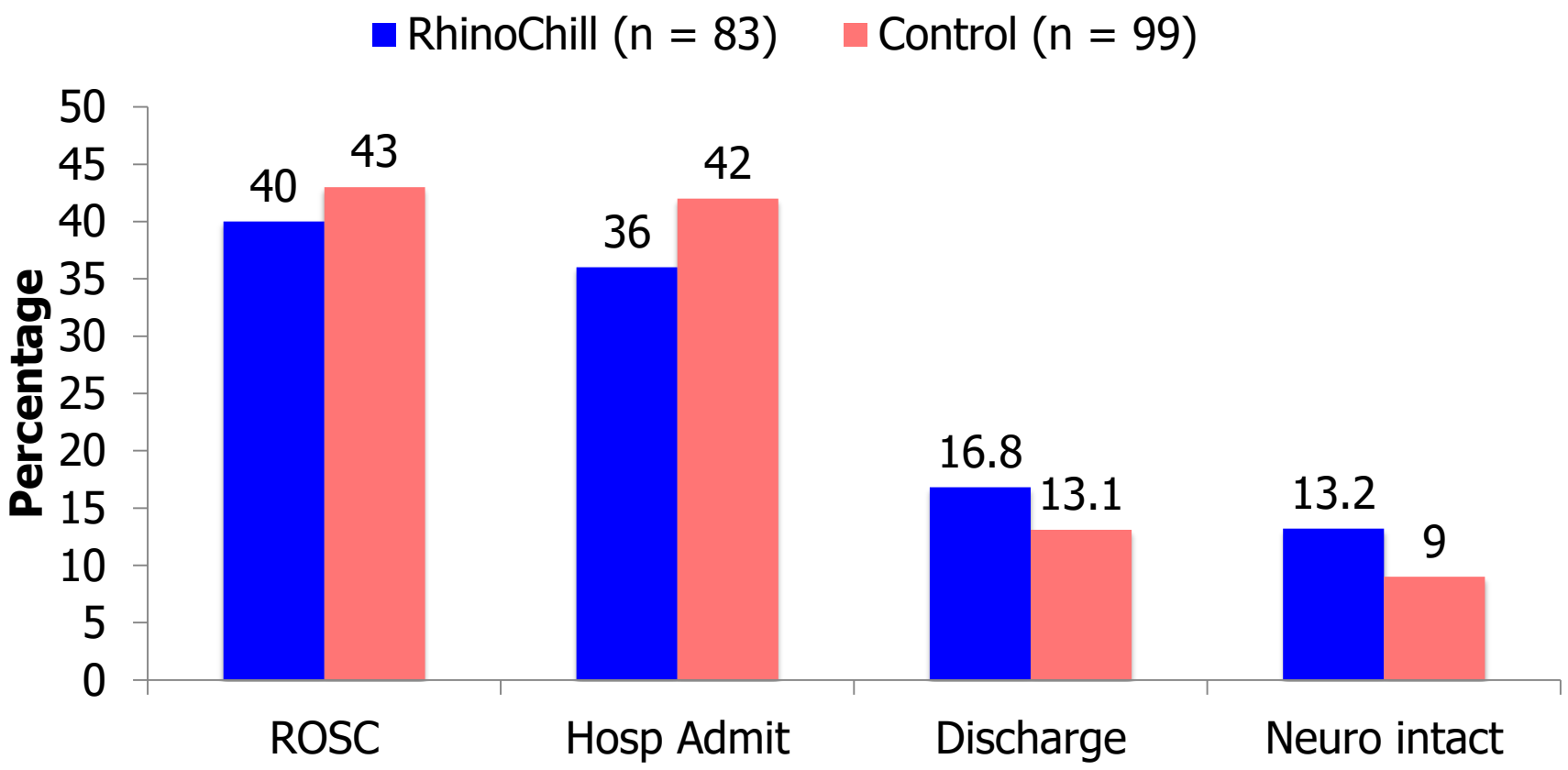

O2-UK 22:21
Adult
Bradycardia Algorithm
Aminophylline
Isoprenaline
Dopamine
Glucagon
(if beta-blocker or calcium channel blocker overdose)
Glycopyrrolate
(can be used instead of atropine)
Previous
First Page

The PRINCE Trial (Pre-ROSC Intra-Nasal Cooling Effectiveness)

- Intra-arrest cooling
  - RhinoChill (n = 83)
  - Control (n = 99)
- Tympanic temp of 34^{o}C reached 3 h sooner with RhinoChill

Castren M. ReSS 2009

The PRINCE Trial

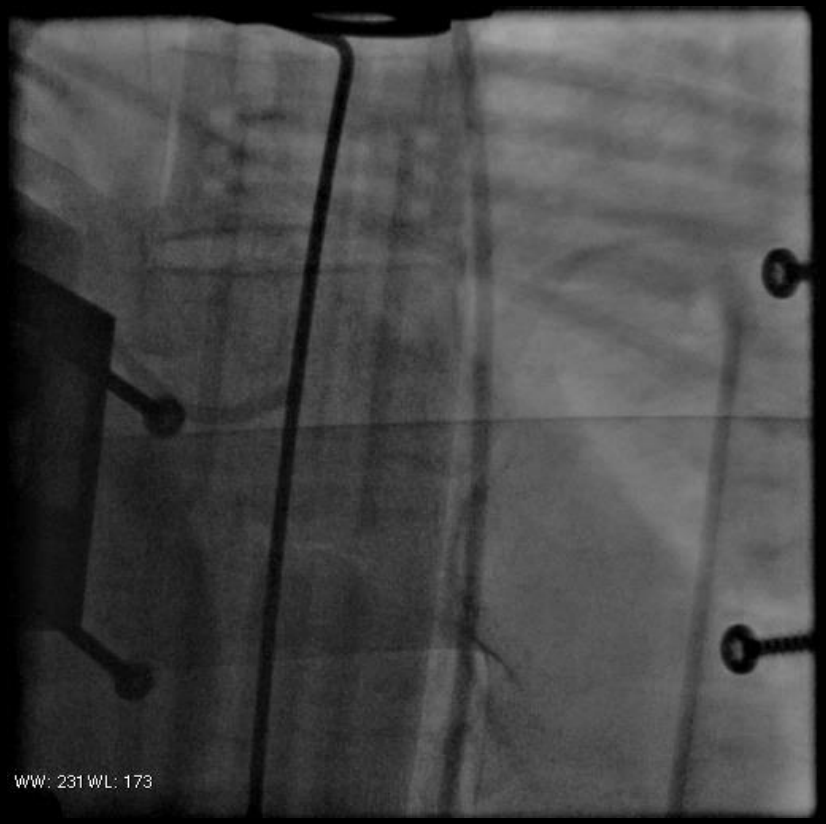


Mechanical CPR to facilitate PCI during cardiac arrest

- LUCAS in 43 patients over 5-year period
- 17 (40%) survived the procedure
- 11 (26%) discharged neurologically good

Wagner H. Resuscitation 2010;81:383-7

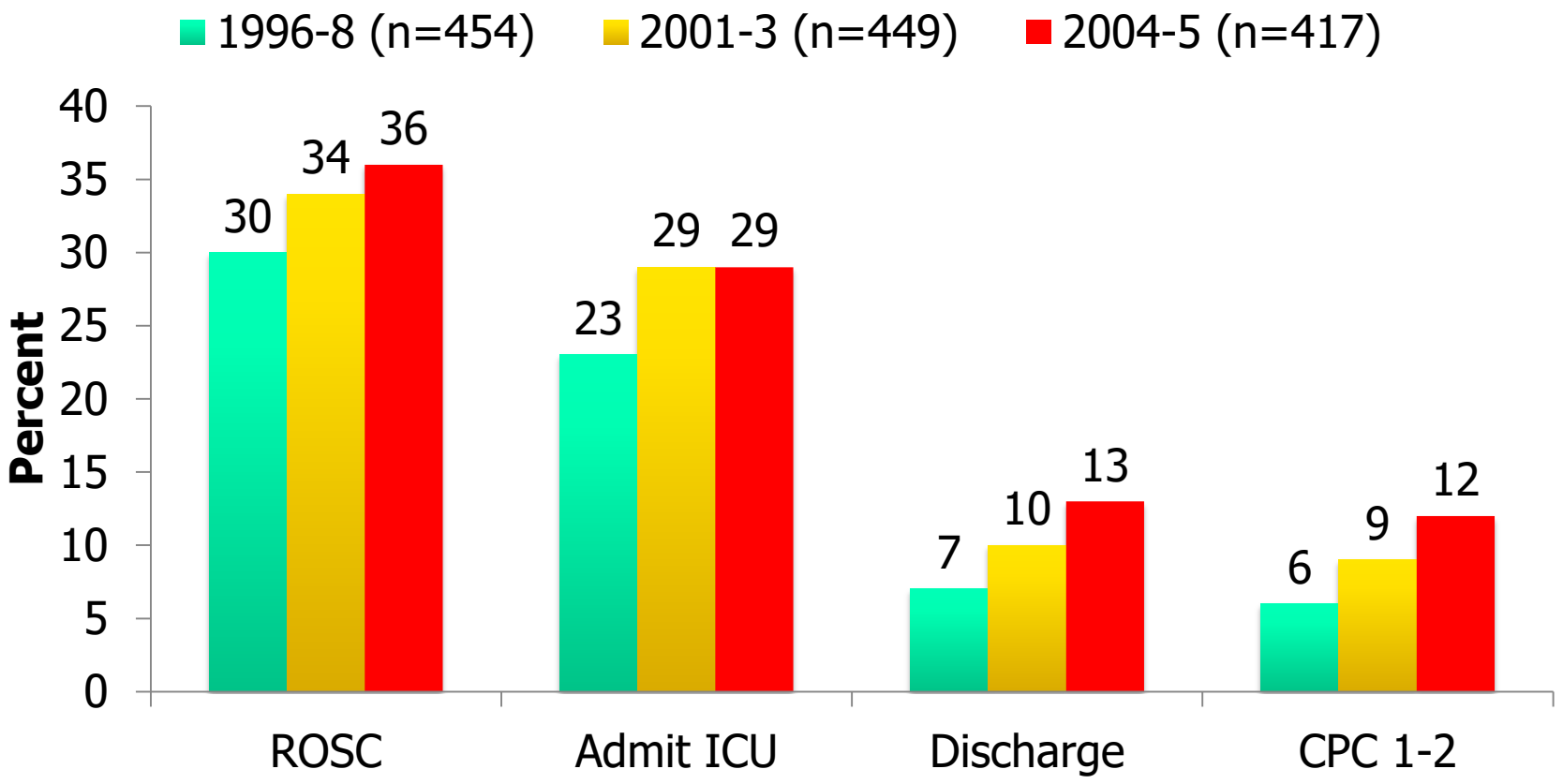
Mechanical CPR to facilitate PCI during cardiac arrest



Courtesy of Sunde K, Oslo


Medtronic

Survival after out-of-hospital cardiac arrest – Oslo, Norway



Lund-Kordahl I. Resuscitation 2010;81:422-6

Hypothermia: Mechanism of action?

- Suppression of free radicals
- Blocking pathological protease cascades
- Suppression of apoptosis (48 h)
- Suppression of pro-inflammatory cytokines (5 days)
  - No? Callaway CW. Crit Care Med 2008;36:2607-12

Polderman K. Lancet 2008;371:1955-69

External techniques: overcooling

- Retrospective review of 32 cases
- Surface cooled to target of 32-34^{o}C
  - 20/32 (63%) < 32^{o}C
  - 9/32 (28%) < 31^{o}C
  - 4/32 (13%) < 30^{o}C
- Rebound hyperthermia (>38^{o}C) at 12-18 h after rewarm in 7/32 (22%)

Merchant RM. Crit Care Med 2006; 34: S490-4

Implementation of standardised post-resuscitation care after OHCA

Sunde K.
Resuscitation 2007;73:29-39

	Control (n=58) 1996 - 8
Reperfusion n (%)	2 (3)
Hypothermia	0
Inotropes	29 (50)
Balloon Pump	0
Insulin	4 (7)
Survival (CPC 1-2)	15 (26)

Implementation of standardised post-resuscitation care after OHCA

Sunde K.
Resuscitation 2007;73:29-39

	Control (n=58) 1996 - 8	Standard (n=61) 2003 - 5
Reperfusion n (%)	2 (3)	30 (49)
Hypothermia	0	40 (66)
Inotropes	29 (50)	43 (80)
Balloon Pump	0	8 (15)
Insulin	4 (7)	27 (44)
Survival (CPC 1-2)	15 (26)	34 (56)

ICU Volume and outcome

ICU cases/year	OR survival	95% CI	p value
<20	1.00	-	-
20-34	0.78	0.55 – 1.11	0.16
35-50	0.71	0.45 – 1.11	0.13
> 50	0.62	0.45 – 0.86	0.01

Carr BG. Resuscitation 2009; 80: 30-34.

Oxygenation: Treatment recommendation

Standards for the Management of Patients After Cardiac Arrest

STANDARDS AND GUIDELINES

- Adjust the FiO_2 to achieve an arterial oxygenation 94-98%