# New Life for the Treatment of Sudden Death: Translating New Guidelines to our Patients


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**E**mergency **R**esuscitation **C**enter

*University of Chicago and*

*Argonne National Laboratory*


E R C

# Conflict of interest disclosures:

- Research funding from NIH, DOD
- Preclinical hypothermia work includes patents for micro-particulate ice slurry

# Other disclosures:

- Mention of non-FDA approved devices for hypothermia

# Objectives

- Highlight new guidelines for cardiopulmonary resuscitation (CPR) and Emergency Cardiovascular Care (ECC)
- Discuss specific examples of translating new guidelines into the clinical setting
- Highlight need to develop physician-scientists in Resuscitation Medicine

Cardiac arrest survival rates are not like those on TV—they have not changed significantly over 3 decades



# Guidelines for CPR and survival

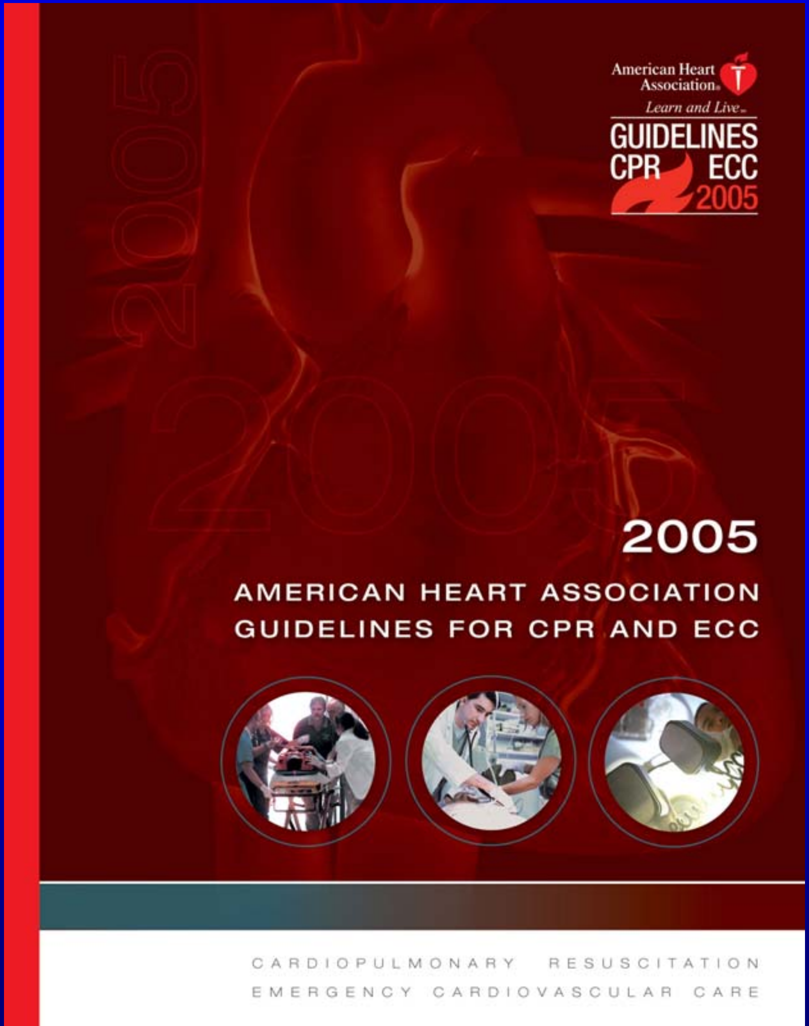
- Guidelines for CPR and ECC are reviewed and updated every 5 years.
- Evidence evaluation process and consensus on science recommendations developed by International Liaison Committee on Resuscitation, of which AHA is a founding member.
- AHA Guidelines were developed by AHA ECC volunteer clinicians, scientists, and researchers.

# Guidelines Process

- International evidence evaluation process reviewed topics in ECC and CPR.
- Review process extended over 36 months and included 281 reviewers, completing 403 reviews on 276 topics.
- Additional information: www.C2005.org

# 2005 Guidelines Changes

Advanced
Cardiovascular
Life Support

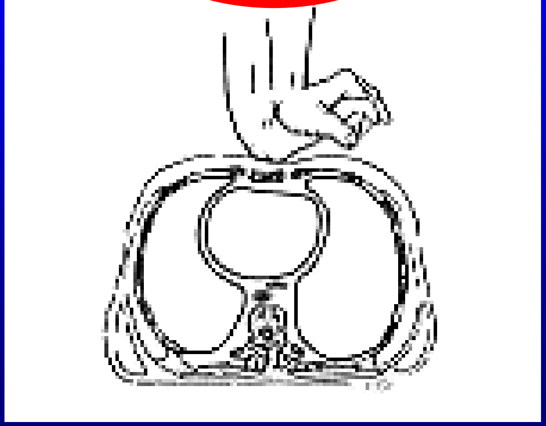


# Science of ACLS

- Recognize peri-arrest conditions
- Cardiopulmonary Resuscitation (CPR): airway, ventilation, chest compressions
- Choreography of CPR with ACLS care
- Defibrillation
- Drug therapy
- Post-resuscitation care
- Emergency Cardiovascular Care:
  ACS and Stroke

Evidence Worksheets posted at: www.C2005.org

# Science of ACLS:  CPR

# Quality of Cardiopulmonary Resuscitation During Out-of-Hospital Cardiac Arrest

Lars Wik, MD, PhD
Jo Kramer-Johansen, MD
Helge Myklebust, BEng
Hallstein Sørebø, MD
Leif Svensson, MD
Bob Fellows, MD
Petter Andreas Steen, MD, PhD

**Context** Cardiopulmonary resuscitation (CPR) guidelines recommend target values for compressions, ventilations, and CPR-free intervals allowed for rhythm analysis and defibrillation. There is little information on adherence to these guidelines during advanced cardiac life support in the field.

**Objective** To measure the quality of out-of-hospital CPR performed by ambulance personnel, as measured by adherence to CPR guidelines.

**Design and Setting** Case series of 176 adult patients with out-of-hospital cardiac arrest treated by paramedics and nurse anesthetists in Stockholm, Sweden, London, England, and Akershus, Norway, between March 2002 and October 2003. The defibrillators recorded chest compressions via a sternal pad fitted with an accelerometer and ventilations by changes in thoracic impedance between the defibrillator pads, in addition to standard event and electrocardiographic recordings.

**Main Outcome Measure** Adherence to international guidelines for CPR.

**Results** Chest compressions were not given 48% (95% CI, 45%-51%) of the time without spontaneous circulation; this percentage was 38% (95% CI, 36%-41%) when subtracting the time necessary for electrocardiographic analysis and defibrillation. Combining these data with a mean compression rate of 121/min (95% CI, 118-124/min) when compressions were given resulted in a mean compression rate of 64/min (95% CI, 61-67/min). Mean compression depth was 34 mm (95% CI, 33-35 mm), 28% (95% CI, 24%-32%) of the compressions had a depth of 38 mm to 51 mm (guidelines recommendation), and the compression part of the duty cycle was 42% (95% CI, 41%-42%). A mean of 11 (95% CI, 11-12) ventilations were given per minute. Sixty-one patients (35%) had return of spontaneous circulation, and 5 of 6 patients discharged alive from the hospital had normal neurological outcomes.

**Conclusions** In this study of CPR during out-of-hospital cardiac arrest, chest compressions were not delivered half of the time, and most compressions were too shallow. Electrocardiographic analysis and defibrillation accounted for only small parts of intervals without chest compressions.

*JAMA. 2005;293:299-304* www.jama.com

SINCE THE FIRST STANDARDS AND guidelines for cardiopulmonary resuscitation (CPR) were published 30 years ago[1] (with the latest update in 2000[2,3]) health care professionals in and out of the hospital have been trained accordingly around the world. The importance of CPR, defined as chest compressions and ventilation, for survival of cardiac arrest patients has been demonstrated,[4] and there are indications that the quality of CPR performance influences the outcome.[5-7]

When tested on mannequins, CPR quality performed by lay rescuers and health care professionals tends to deteriorate significantly within a few months after training,[8-10] but little is known about the quality of clinical performance on pa-

# Quality of CPR Out-of-Hospital

- Case series n=176 (Stockholm, London, Akershus)
- Outcome measure = G2000 standards
- Chest compressions were not delivered 48% of the time
- Most compressions were too shallow
- ECG analysis and defib accounted for only a small part of chest compression interruption

Wik et al. JAMA 2005; 293:299-304

# Quality of Cardiopulmonary Resuscitation During In-Hospital Cardiac Arrest

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Dana P. Edelson, MD
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Terry L. Vanden Hoek, MD
Lance B. Becker, MD

**Context** The survival benefit of well-performed cardiopulmonary resuscitation (CPR) is well-documented, but little objective data exist regarding actual CPR quality during cardiac arrest. Recent studies have challenged the notion that CPR is uniformly performed according to established international guidelines.

**Objectives** To measure multiple parameters of in-hospital CPR quality and to determine compliance with published American Heart Association and international guidelines.

**Design and Setting** A prospective observational study of 67 patients who experienced in-hospital cardiac arrest at the University of Chicago Hospitals, Chicago, Ill, between December 11, 2002, and April 5, 2004. Using a monitor/defibrillator with novel additional sensing capabilities, the parameters of CPR quality including chest compression rate, compression depth, ventilation rate, and the fraction of arrest time without chest compressions (no-flow fraction) were recorded.

**Main Outcome Measure** Adherence to American Heart Association and international CPR guidelines.

**Results** Analysis of the first 5 minutes of each resuscitation by 30-second segments revealed that chest compression rates were less than 90/min in 28.1% of segments. Compression depth was too shallow (defined as <38 mm) for 37.4% of compressions. Ventilation rates were high, with 60.9% of segments containing a rate of more than 20/min. Additionally, the mean (SD) no-flow fraction was 0.24 (0.18). A 10-second pause each minute of arrest would yield a no-flow fraction of 0.17. A total of 27 patients (40.3%) achieved return of spontaneous circulation and 7 (10.4%) were discharged from the hospital.

**Conclusions** In this study of in-hospital cardiac arrest, the quality of multiple parameters of CPR was inconsistent and often did not meet published guideline recommendations, even when performed by well-trained hospital staff. The importance of high-quality CPR suggests the need for rescuer feedback and monitoring of CPR quality during resuscitation efforts.

*JAMA. 2005;293:305-310* www.jama.com

SURVIVAL FROM CARDIAC ARREST remains low despite the introduction of cardiopulmonary resuscitation (CPR) more than 50 years ago.[1-3] The delivery of CPR, with correctly performed chest compressions and ventilations, exerts a significant survival benefit in both animal and human studies.[4-8] Conversely, interruptions in CPR or failure to provide compressions during cardiac arrest ("no-flow time") have been noted to have a negative impact on survival in animal studies.[7] Consensus guidelines clearly define how CPR is to be performed,[9] but the parameters of CPR in actual practice are not routinely measured, nor is the quality known.

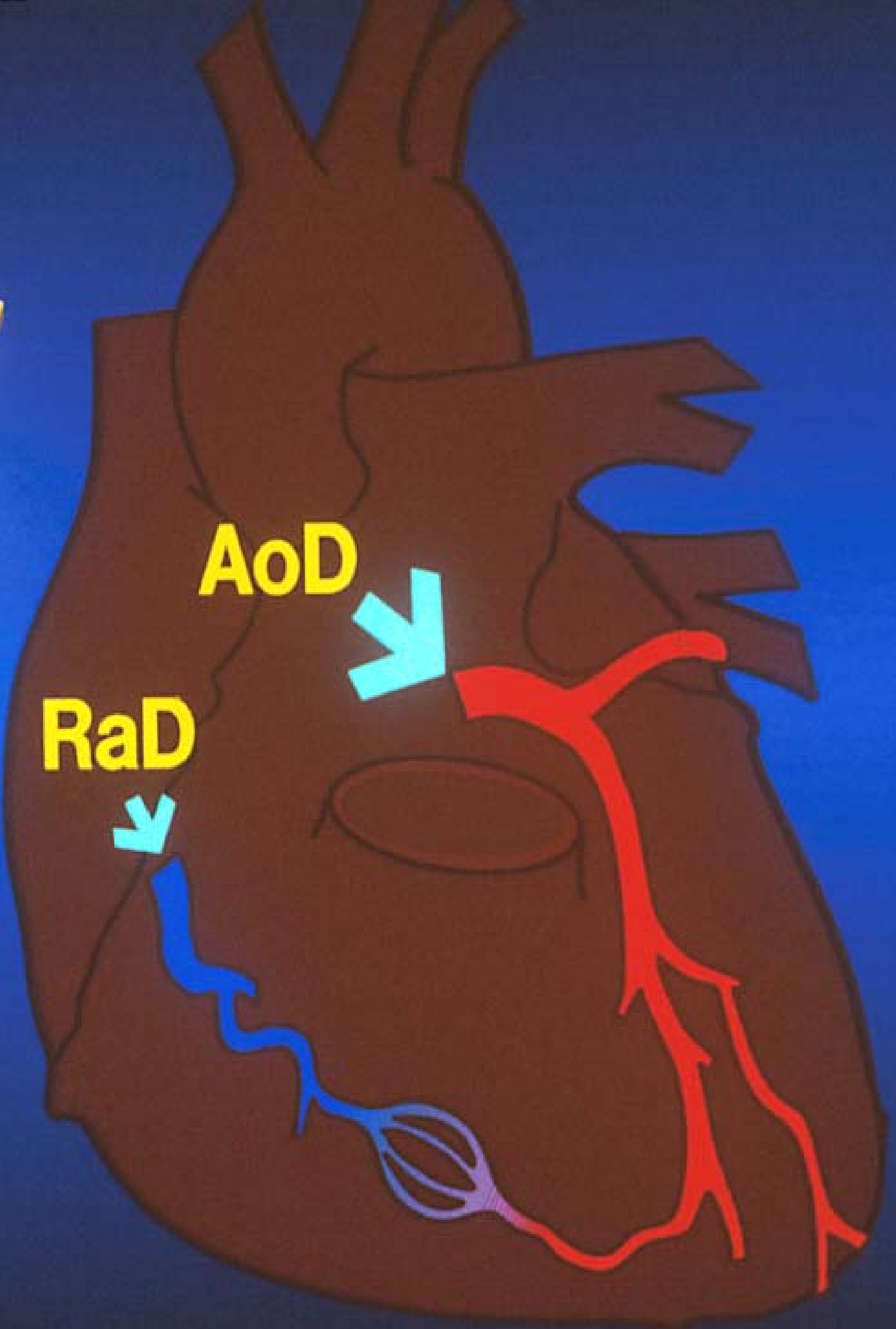
There are multiple reasons for con-

# Quality of CPR During In-Hospital Cardiac Arrest

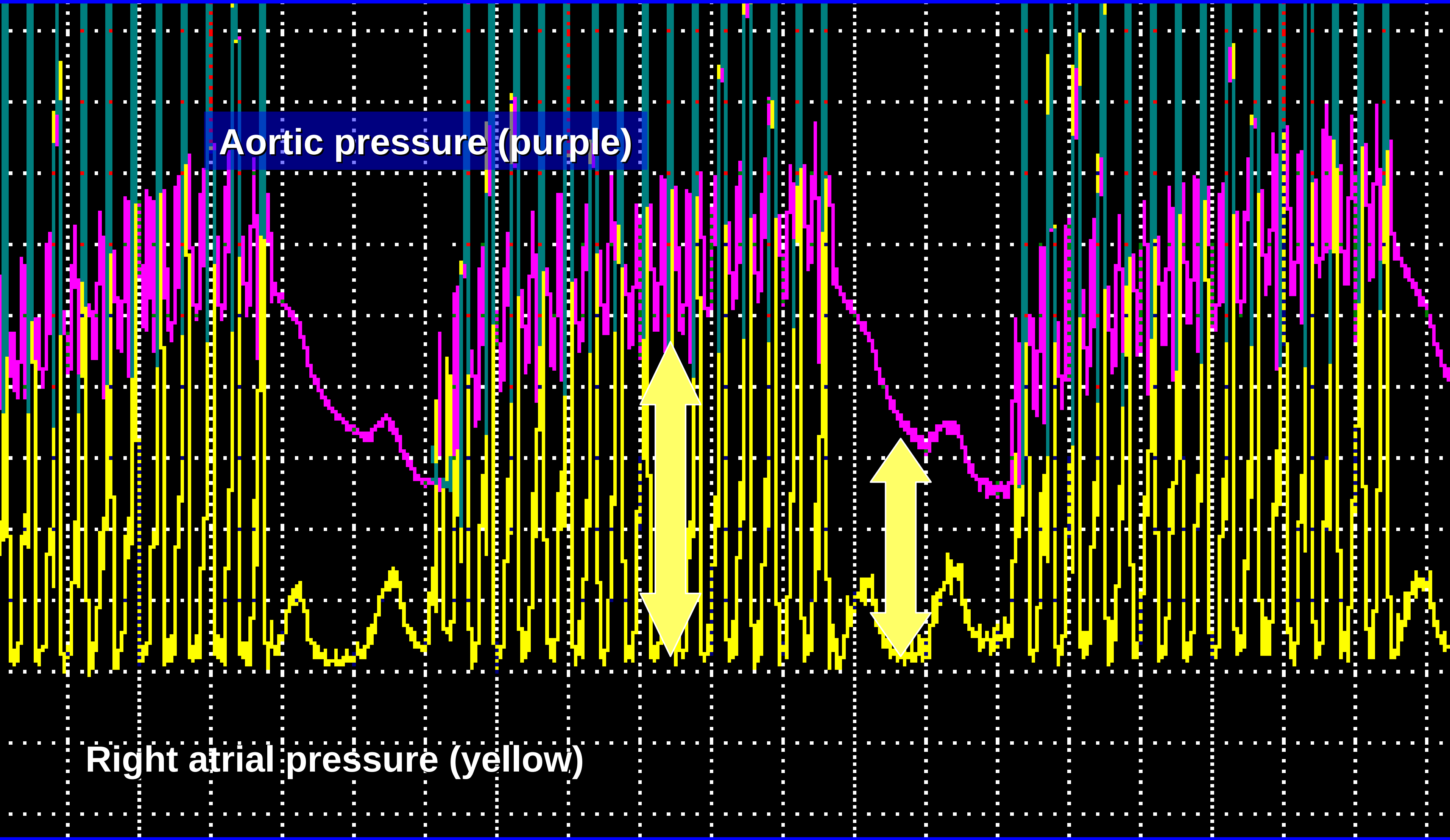
- Case series n=67 (Chicago)
- Outcome measure = G2000 standards
- Chest compressions were too slow
- Chest compressions not delivered almost 25% of the time
- 38% of the compressions were too shallow
- Ventilation rates were too high

Abella B. *JAMA* 2005; 293:305-310

"Coronary Perfusion Pressure" During CPR

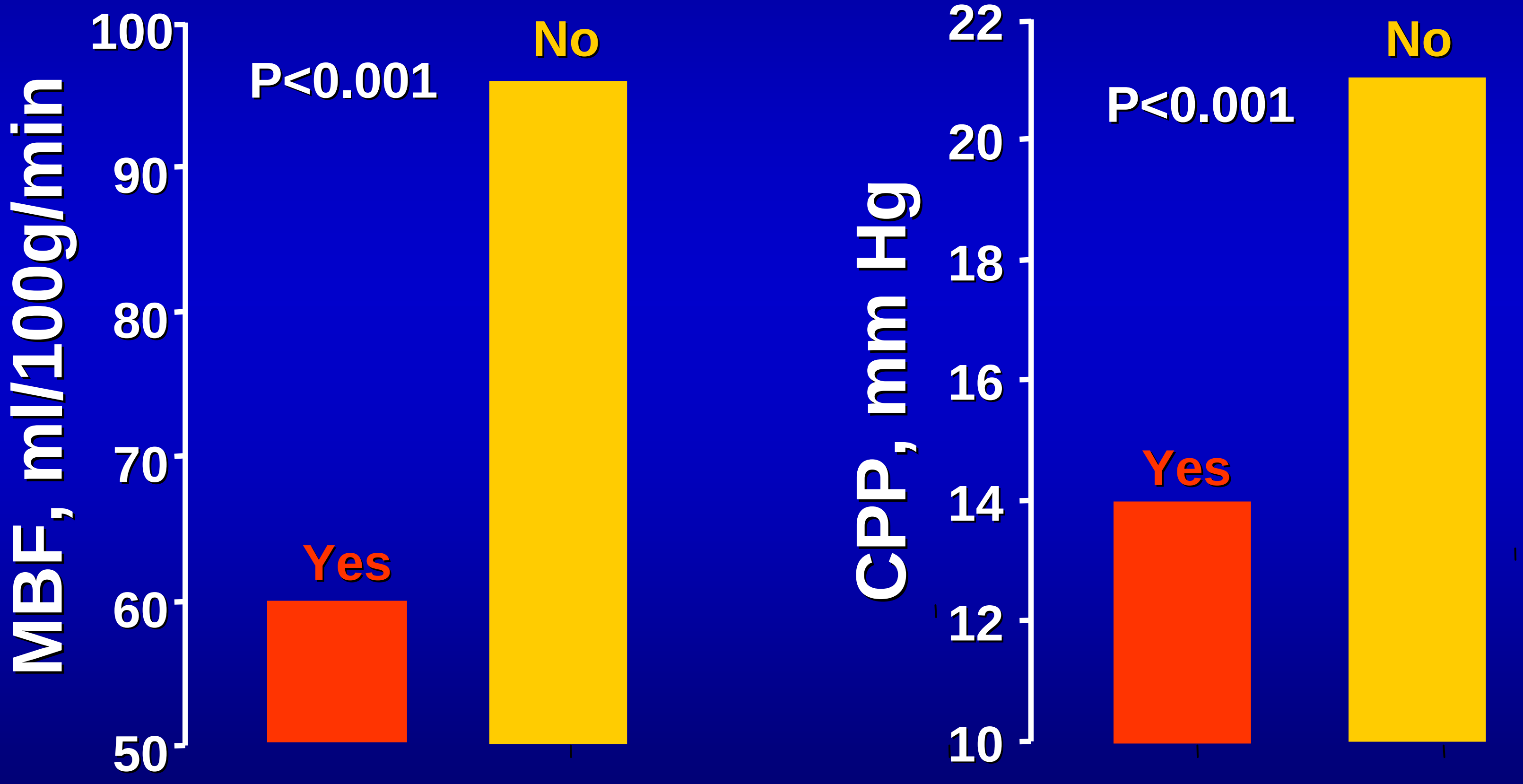


# Ventricular Fibrillation and CPR




Coronary Perfusion Pressure (Ao diastolic - RA diastolic)

# Swine myocardial blood flow and CPP after interrupted CPR (16 second pauses)

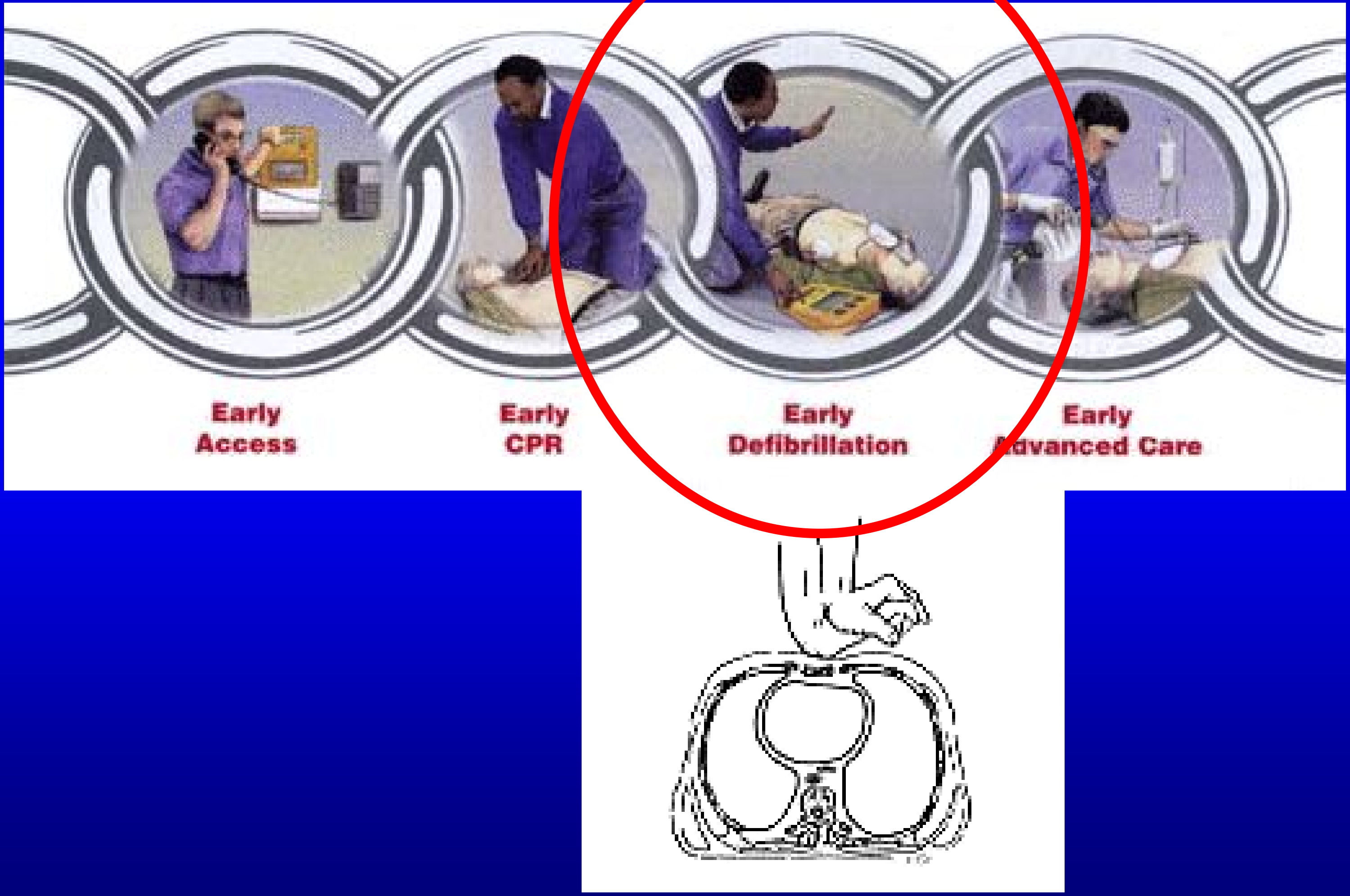



Berg RA et al: Circulation 2001;104:2465-70

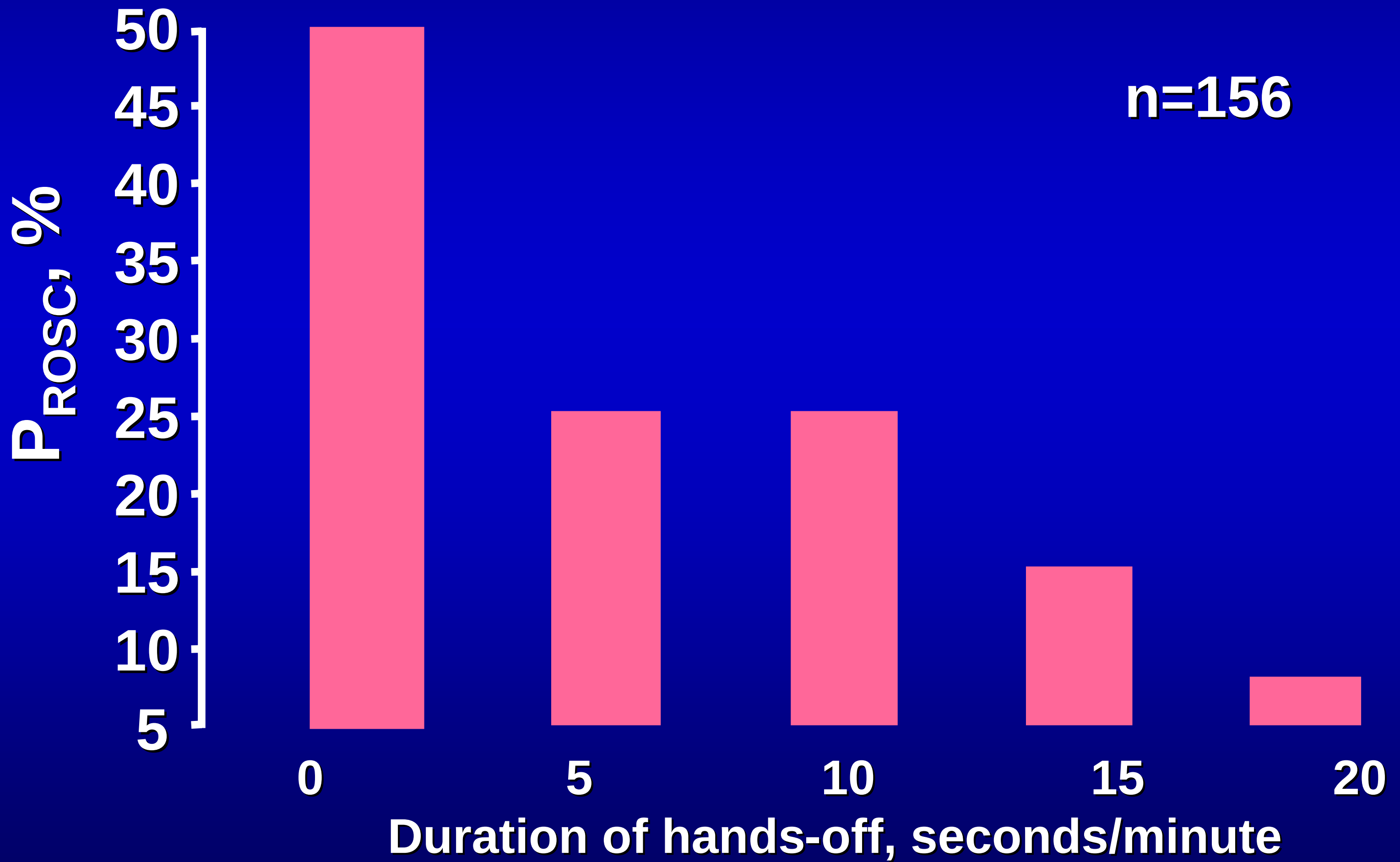
# Neurologically normal 24-hour survival in swine with interrupted CPR (16 second pauses)


Kern KB et al: Circulation 2002;105:645-9

# CPR and defibrillation



# Effects of interrupting chest compression on calculated probability of successful defibrillation during out-of-hospital cardiac arrest




Eftestol T et al: Circulation 2002;105:2270-3

# Healthcare Provider – CPR

## Universal compression to ventilation ratio

- All victims: *30:2* compressions to ventilations *(*single rescuer).
- Minimize interruptions.  Allow for complete chest recoil.
- Infant/child: *15:2* compression to ventilation ratio (2-rescuers).

# Healthcare Provider – CPR

## Change compressors (2-rescuers)

- Change "compressor" role every 2 minutes or 5 cycles of CPR.
- Complete switch in 5 seconds or less.

# Translating New Guidelines into Clinical CPR Quality

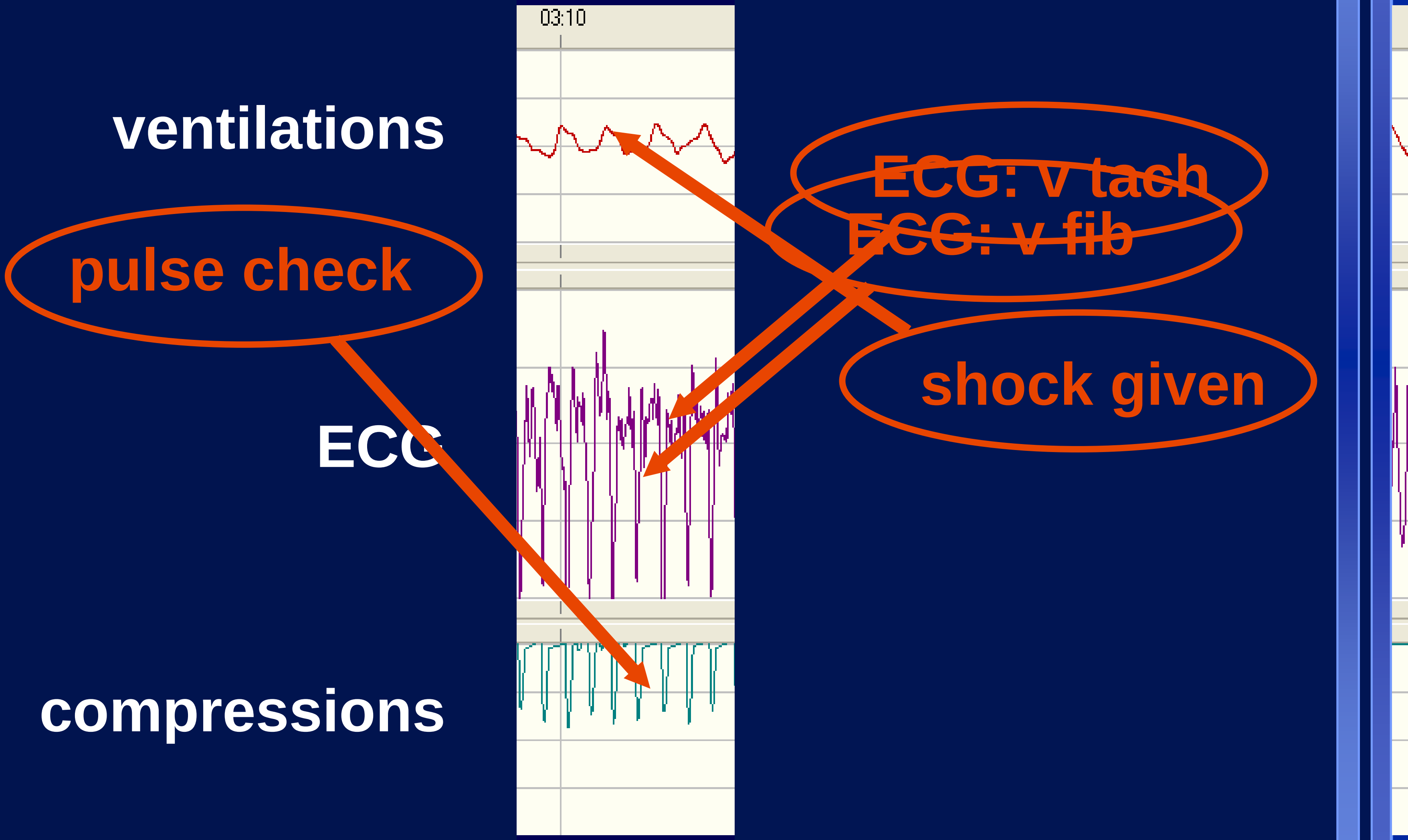

**Defibrillator customized
With sensors to detect:**

- **Chest compression rate and depth**
- **Ventilation rate and volume**
- **Pulse presence or absence**

**Records entire arrest transcript for analysis**

***Abella et al, 2005***
***Edelson et al, 2006***

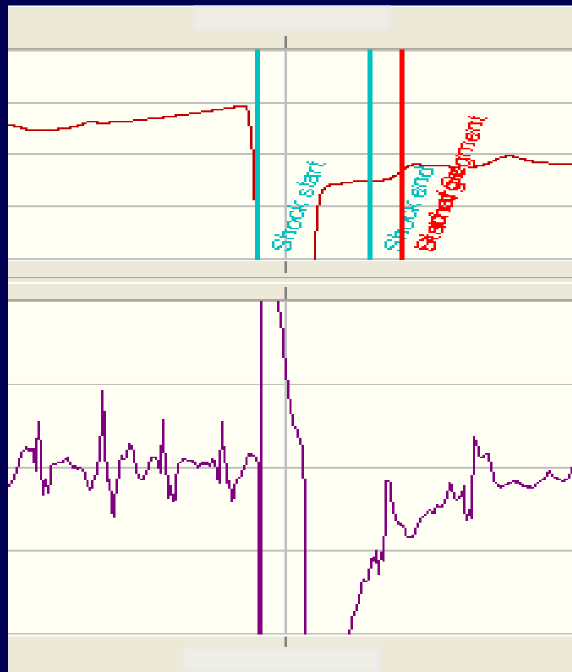
# Arrest transcript



# Examples of arrest data

Event

ECG

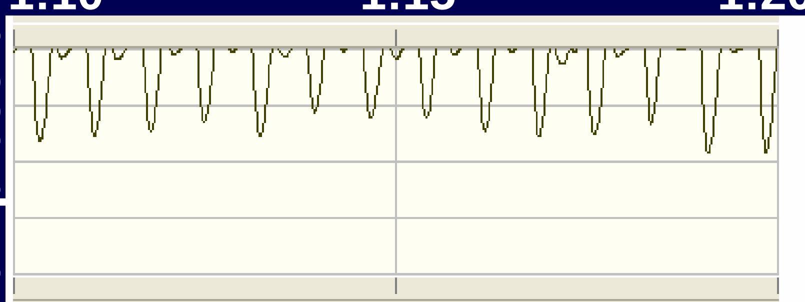



Inappropriate shock for PEA


Compression rate = 78 /min

1:10 1:15 1:20

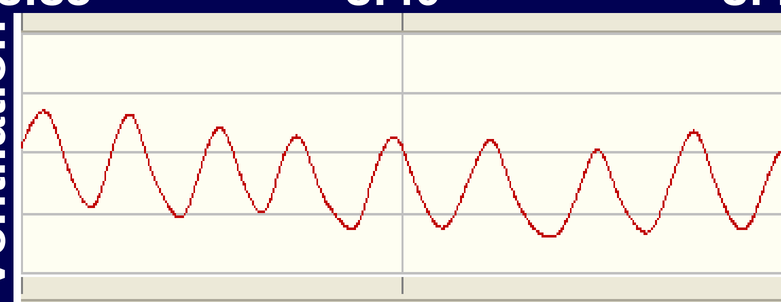
Compression



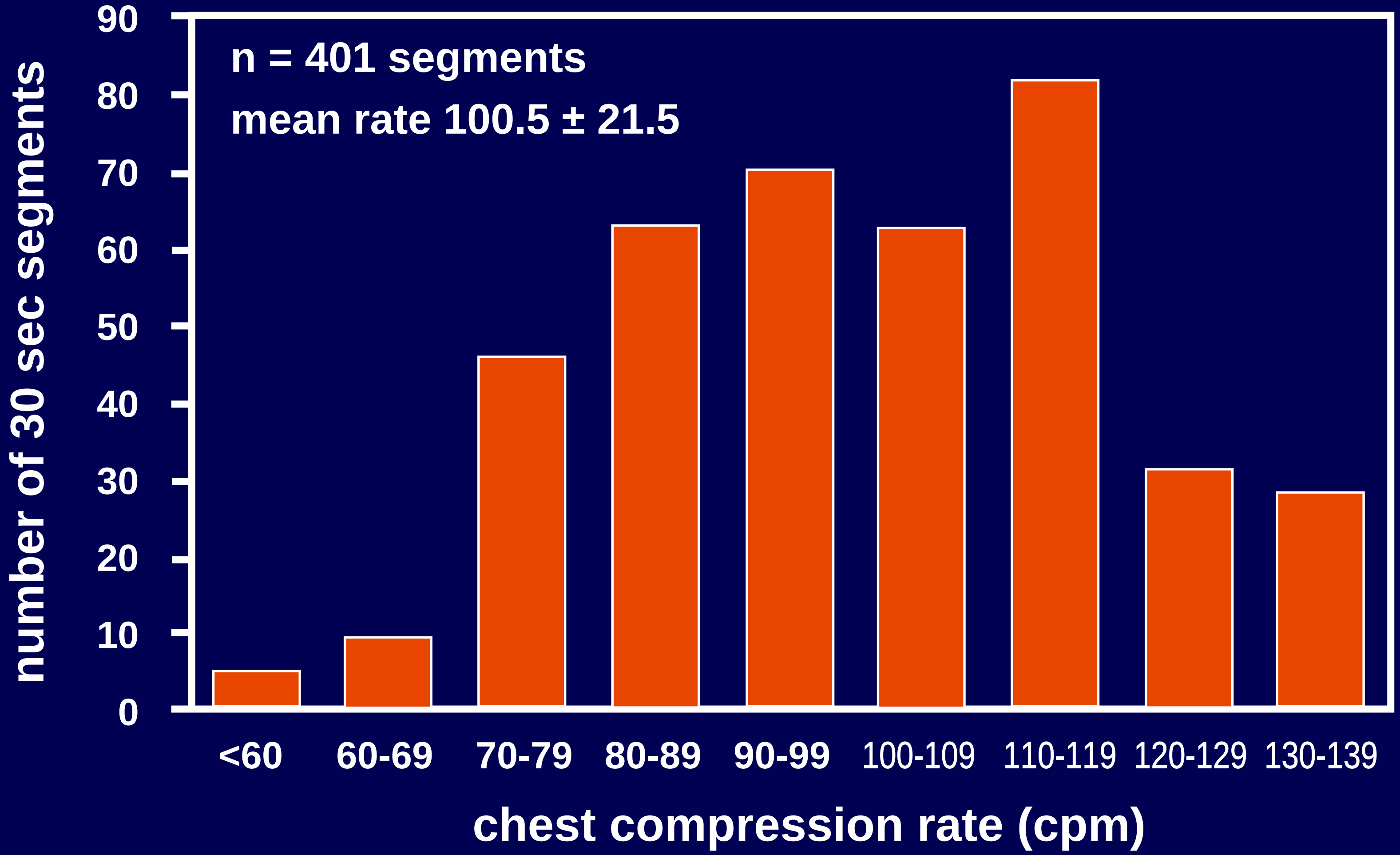
Ventilation rate = 48 /min

3:35 3:40 3:45

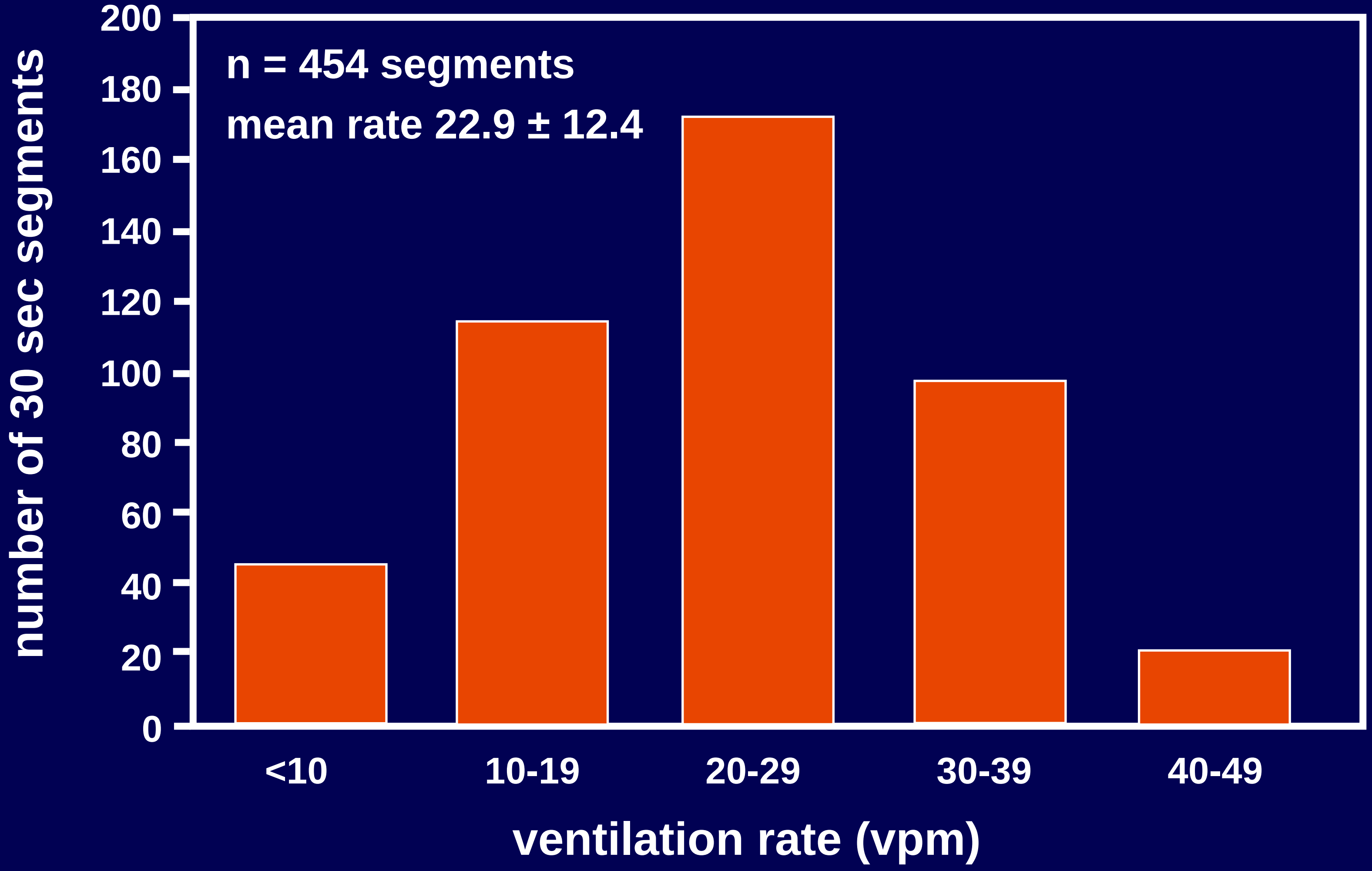
Ventilation



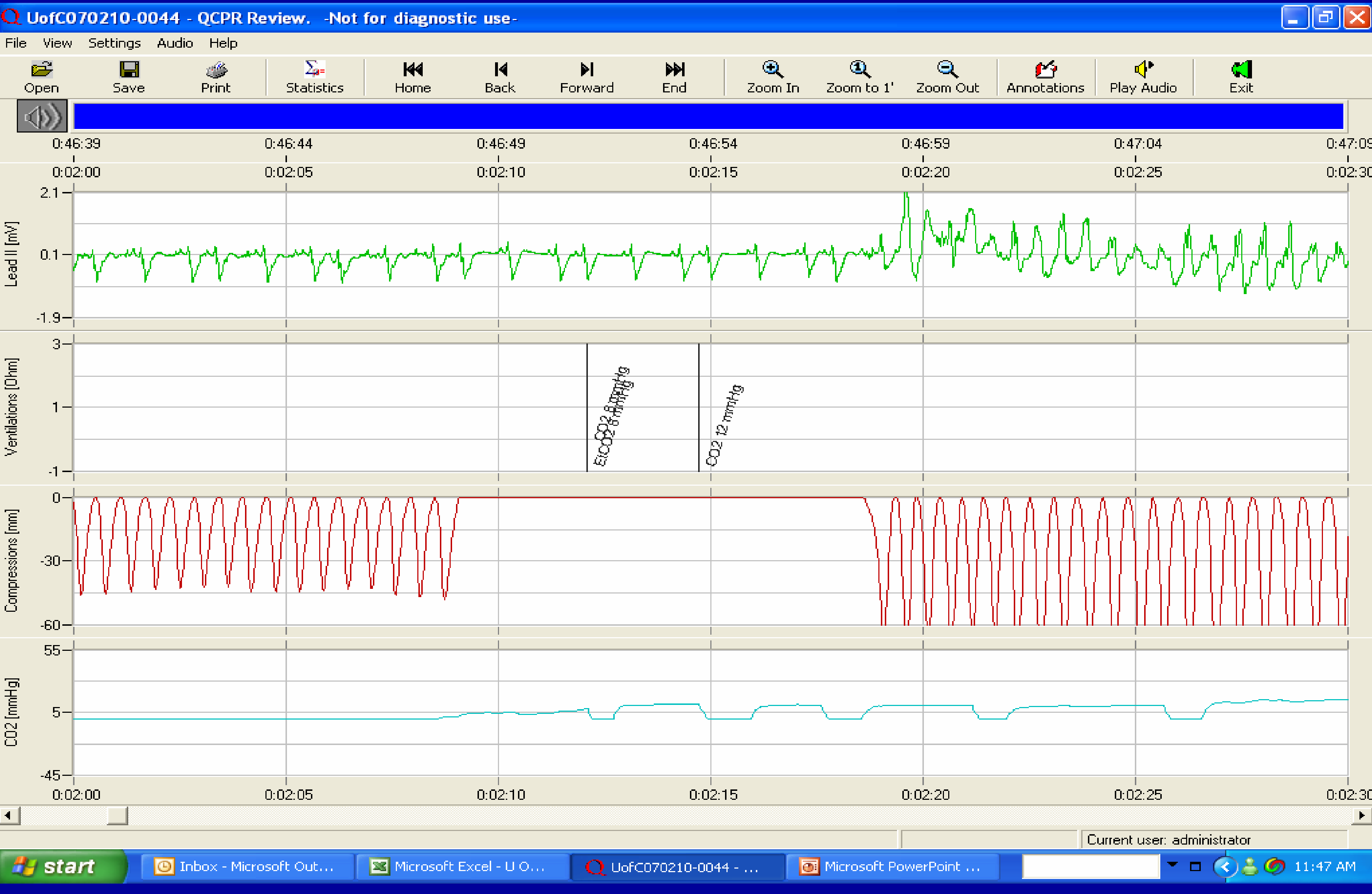
# Chest compression rates



# Ventilation rates



# Code Team Review



# ACLS – Postresuscitation

## Hypothermia

- Unconscious adult patients with ROSC after out-of-hospital cardiac arrest (VF) should be cooled to 32$^{o}$C to 34$^{o}$C for 12 hours.
- Similar therapy may be beneficial for patients with non-VF arrest out-of or in-hospital arrest.
- Further research is needed.

# Thinking about the basics of therapeutic hypothermia

- Early patient identification:  finding the group of cardiac arrest patients who will benefit most from cooling
- Cooling methods:  external, internal, expensive and cheap
- Importance of a multidisciplinary approach

# Patients who benefit from cooling therapy

The New England Journal of Medicine



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*

INDUCED HYPOTHERMIA AFTER OUT-OF-HOSPITAL CARDIAC ARREST

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

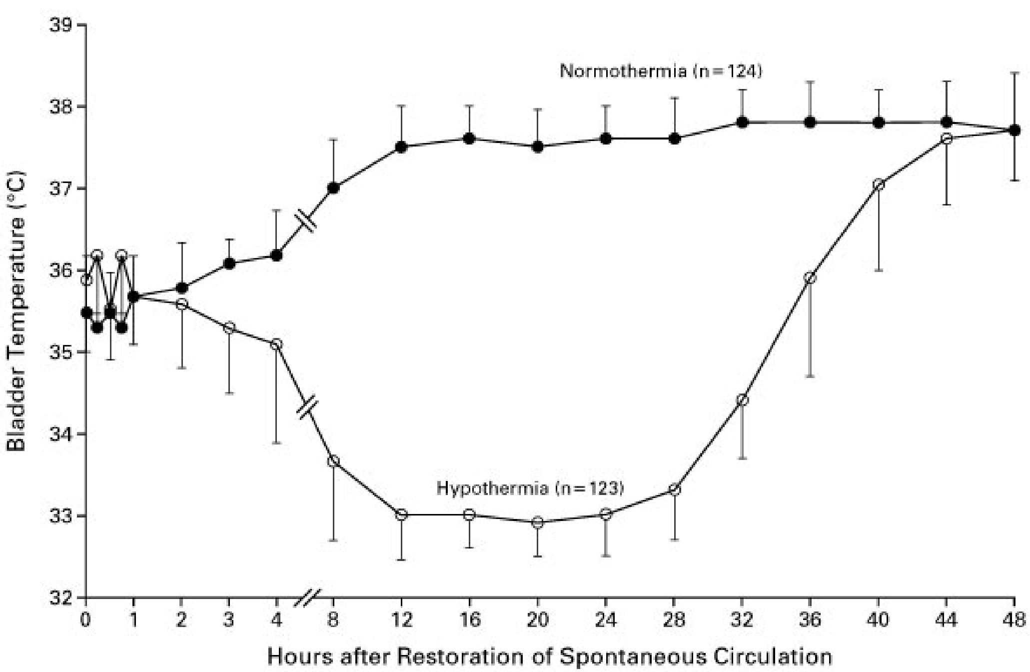
STEPHEN A. BERNARD, M.B., B.S., TIMOTHY W. GRAY, M.B., B.S., MICHAEL D. BUIST, M.B., B.S.,
BRUCE M. JONES, M.B., B.S., WILLIAM SILVESTER, M.B., B.S., GEOFF GUTTERIDGE, M.B., B.S., AND KAREN SMITH, B.SC.

**Less than 10% of presenting cardiac arrest patients with return of spontaneous circulation (ROSC) were considered for cooling in clinical studies:**

- Witnessed cardiac arrest
- Comatose but hemodynamically stable
- In the Hypothermia after Cardiac Arrest (HACA) study: 3,551 pts assessed, 275 enrolled
- Other selected inclusion/exclusion criteria:
  - **VF or pulseless Vtach as initial rhythmn**
  - **Presumed cardiac origin**
  - **No prolonged hypotension (MAP<60mmHg for >30min) or hypoxia ( O2 sat <85% for >15min)**

# Cooling methods

- Surface cooling




Ice bags in addition to cooling blanket required in about 70% of pts to reach target temp

# Cooling methods

- Surface cooling

Review — Hypothermia in stroke

**Therapeutic hypothermia for acute stroke**

*Lancet Neurology* 2003; **2:** 410–16

Tom Skyhøj Olsen, Uno Jakob Weber, and Lars Peter Kammersgaard

# Cooling methods

- Internal cooling

Induced hypothermia using large volume, ice-cold intravenous fluid in comatose survivors of out-of-hospital cardiac arrest: a preliminary report

Stephen Bernard [a,b,*], Michael Buist [a], Orlando Monteiro [a], Karen Smith [b]

[a] The Intensive Care Unit, Dandenong Hospital, David St, Dandenong, Victoria 3175, Australia
[b] Department of Epidemiology and Preventive Medicine, Monash University, St Kilda Rd, Prahran 3181, Victoria, Australia

S. Bernard et al. / Resuscitation 56 (2003) 9–13

--22 pts  post ROSC who remained comatose
--30ml/kg of ice-cold saline given via peripheral IV or femoral central line over 30 min after patient evaluated and paralyzed
--Decreased core temp from 35.5 to 33.8 $^{o}$C

# Cooling methods

- Internal cooling

Anesthesiology
2000; 93:629-37


## *Core Cooling by Central Venous Infusion of Ice-cold (4°C and 20°C) Fluid*

### *Isolation of Core and Peripheral Thermal Compartments*

*Angela Rajek, M.D.,* Robert Greif, M.D.,† Daniel I. Sessler, M.D.,‡ James Baumgardner, M.D, Ph.D.,§ Sonja Laciny, M.D.,‖ Hiva Bastanmehr, B.S.#*

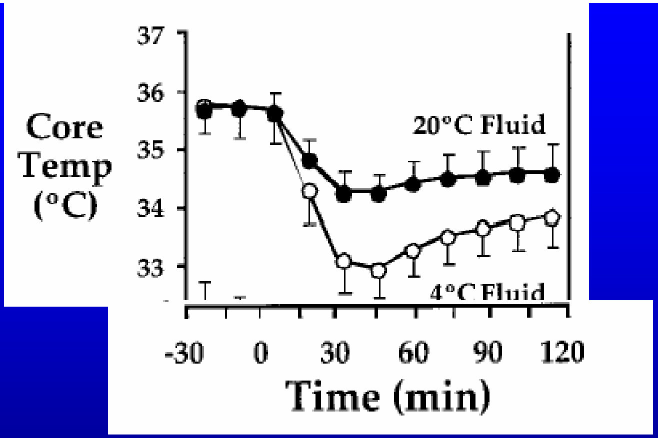



**Fig. 1.** Core, peripheral tissue, and mean body temperatures before and after fluid infusion. The infusion of 40 ml/kg at 4°C (open circles) and 20°C (filled circles) began at elapsed time zero and lasted for 30 min. Results are presented as mean ± SD.

# Cooling methods

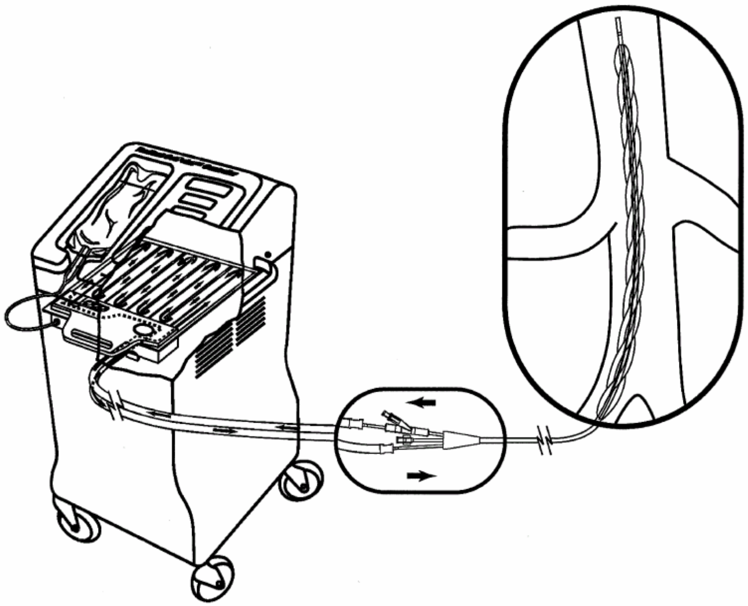
Induction of Mild Systemic Hypothermia With Endovascular Cooling During Primary Percutaneous Coronary Intervention for Acute Myocardial Infarction

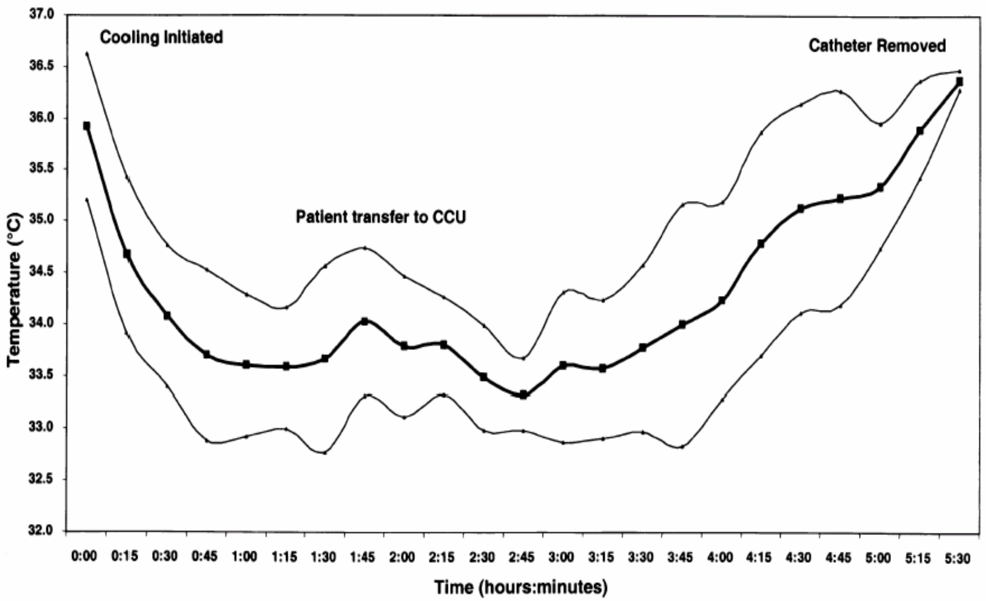
Simon R. Dixon, MBChB, FRACP,* Robert J. Whitbourn, MBBS, FRACP,†
Michael W. Dae, MD, FACC,‡ Eberhard Grube, MD,§ Warren Sherman, MD, FACC,‖
Gary L. Schaer, MD, FACC,¶ J. Stephen Jenkins, MD, FACC,# Donald S. Baim, MD, FACC,**
Raymond J. Gibbons, MD, FACC,†† Richard E. Kuntz, MD, FACC,** Jeffrey J. Popma, MD, FACC,**
Thanh T. Nguyen, DO,* William W. O'Neill, MD, FACC*

*Royal Oak, Michigan; Melbourne, Australia; San Francisco, California; Siegburg, Germany; New York, New York; Chicago, Illinois; New Orleans, Louisiana; Boston, Massachusetts; and Rochester, Minnesota*

JACC Vol. 40, No. 11, 2002
December 4, 2002:1928–34

- Internal cooling





# Therapeutic hypothermia after cardiac arrest: Practical considerations for protocol development and implementation strategies

http://www.therapeutichypothermia.com

# Course Faculty

**Mary Ann Peberdy, MD, FACC**
Associate Professor of Medicine and Emergency Medicine
Virginia Commonwealth University

**Terry L. Vanden Hoek, MD**
Associate Professor of Emergency Medicine
University of Chicago

http://www.therapeutichypothermia.com

# From basic discovery to life-saving devices and treatments: How do we accelerate discovery?


**Critical Role of the Physician-Scientist**

# Physician-Scientists are needed to close the gap between data/discovery and new life-saving devices and treatments

- Physician-scientists: those individuals holding an M.D. or M.D./Ph.D. degree who perform biomedical research as their primary professional activity.

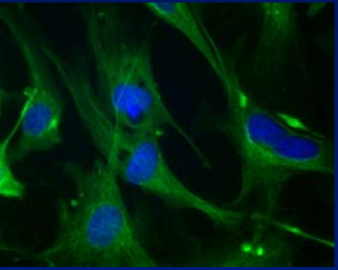
- The number of physician-scientists in U.S. has been declining for the last 2 decades, down 22% from 18,535 in 1983 to 14,479 in 1998.

Ley TJ & Rosenberg LE. Removing career obstacles for young physician-scientists—loan repayment programs. *N Engl J Med 346, 368-372 (2002)*

# Physician-Scientists are needed to close the gap between data/discovery and new life-saving devices and treatments

- "As we enter the post-genomic era, physician-scientists will have the specialized perspectives required to lead evolving fields such as genetic medicine, pharmacogenetics, and bioinformatics. As this research is translated into patient treatment protocols, it is physician-scientists who will have the necessary training and skills to ensure that these protocols are designed and evaluated in ethical and rigorous clinical trials."

*The FASEB Journal 14, 221-230 (2000)*



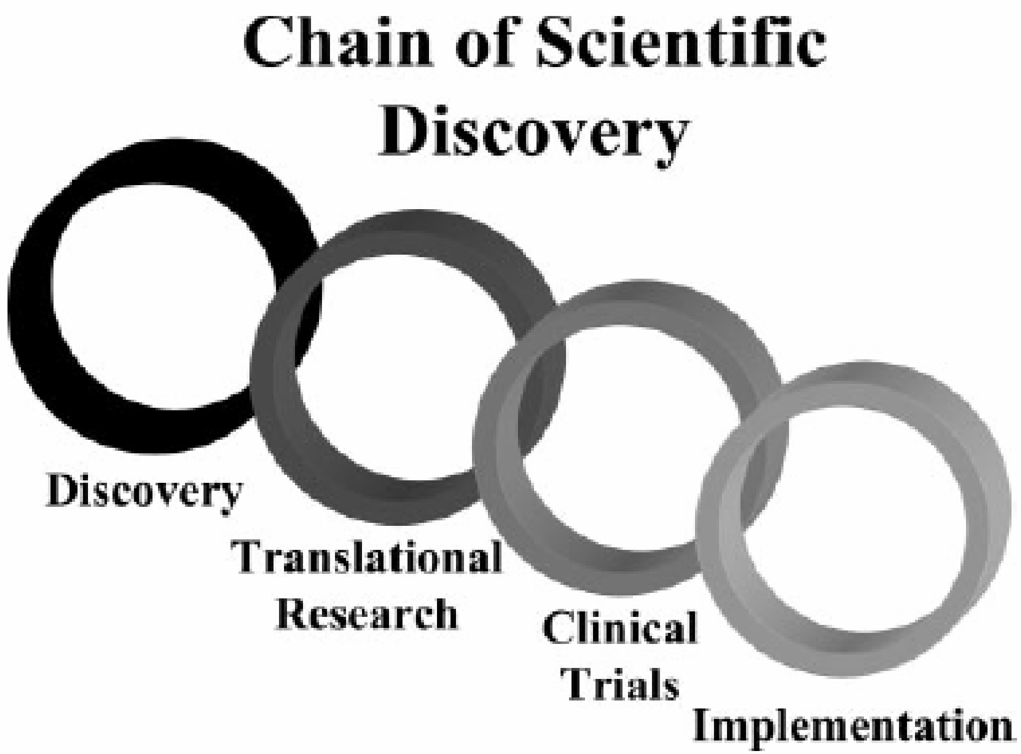



Figure 2. The chain of scientific discovery.

*Faxon D, Circulation 105, 1857-1860 (2002)*

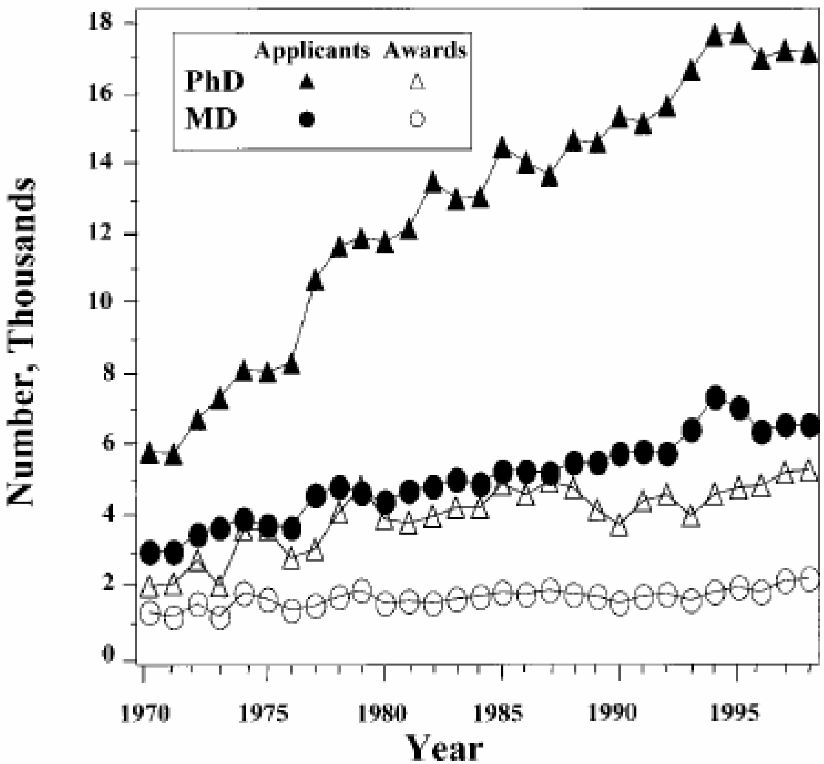



**Figure 14.** Number of RPG applicants and awards. The total number of applications for NIH research project grants (RPGs) and awards of RPGs by professional degree. Data provided by the NIH Office of Extramural Research.

# Make path of research/discovery less difficult.

So much information
So little time & money
So few mentors
So little representation on National funding committees

*The FASEB Journal 14, 221-230 (2000)*

*Internal Medicine Journal* 2004; 34: 75

EDITORIAL

The physician scientist: an endangered breed?

## Box 1 National organizations expressing concern about the physician-scientist career pathway

- American Medical Association
- American Society for Clinical Investigation
- Association of American Medical Colleges
- Federation of American Societies for Experimental Biology
- Howard Hughes Medical Institute
- Institute of Medicine
- NRC Committee on National Needs for Biomedical and Behavioral Research
- NIH Director's Panel on Clinical Research

*Nature Medicine 8 (5), 437-439 (2002)*

## Box 2 Emerging opportunities for revitalization of physician-scientist careers

- Loan repayment programs from NIH for extramural trainees engaged in clinical research
- Loan repayment programs for NIH intramural trainees
- Career development programs of NIH
- Howard Hughes Medical Institute appointments to investigators doing patient-oriented research
- Support of physician-scientist training and career development by not-for-profit agencies
- Development of degree-granting postdoctoral programs for MDs at academic institutions
- Establishment of the Association for Patient-Oriented Research

*Nature Medicine 8 (5), 437-439 (2002)*

Excerpta Medica

The American Journal of Surgery

The American Journal of Surgery 185 (2003) 42–44

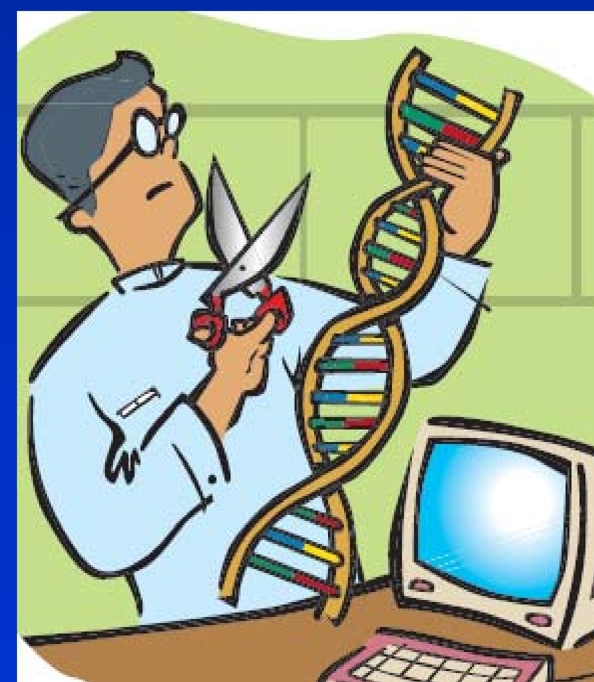
Editorial opinion

# Collaboration based on the clinical model can help grow the physician-scientist

Peter K. Henke, M.D.*

*Section of Vascular Surgery, Department of Surgery, University of Michigan, 2210D THCC, 1500 East Medical Center Dr., Ann Arbor, MI 48109, USA*

Manuscript received May 2, 2002; revised manuscript July 1, 2002

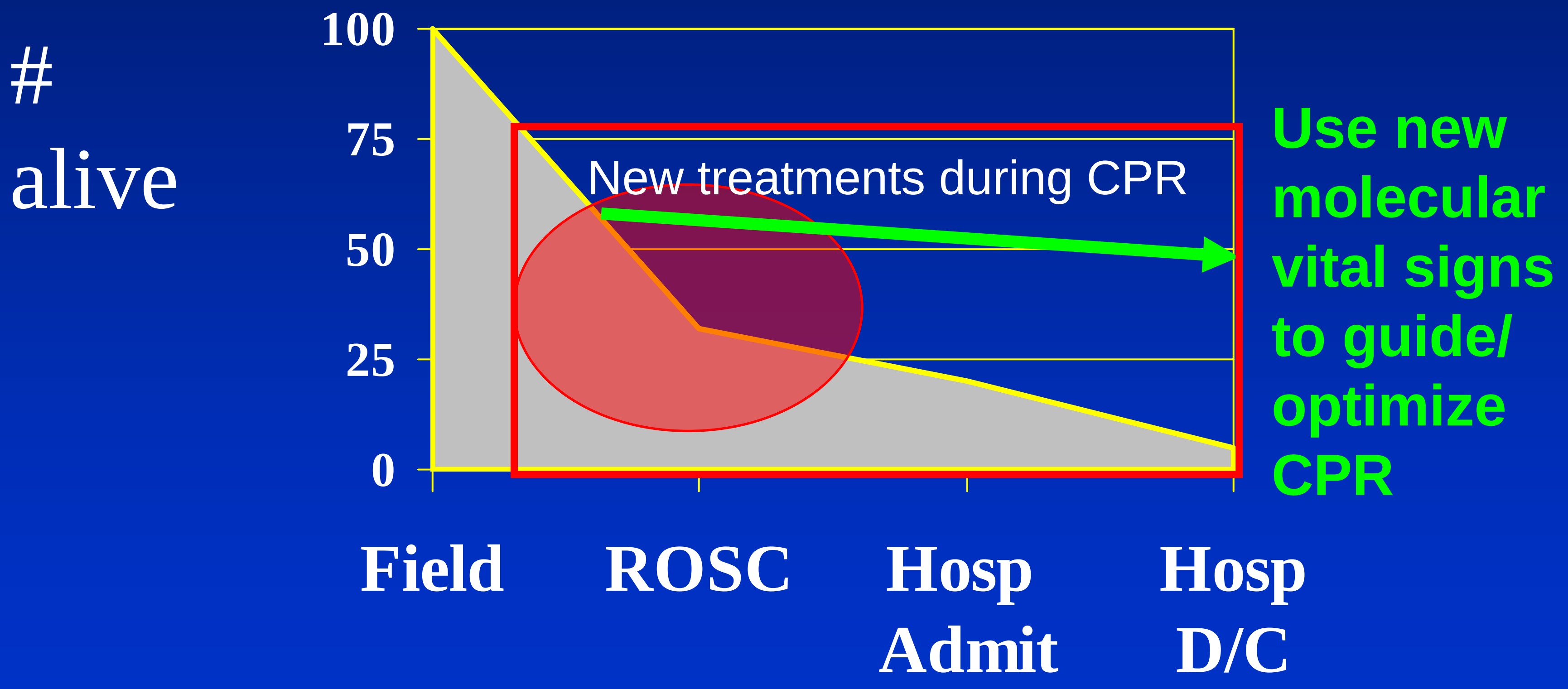



# Emergency Resuscitation Center

## University of Chicago and Argonne National Laboratory

"Health care providers, scientists and bioengineers working together to restore life after sudden death."

# Clinical potential for new metabolic resuscitation strategies




1999, CPR; Weil and Tang ed.

# Vision

Sudden death patients who are currently pronounced "dead" after sudden cardiovascular shock will routinely be resuscitated back to full human function.

# Mission Statement: Key Goals

- **Restore life** to victims of sudden death by developing innovative resuscitation strategies.
- **Translate basic science discoveries** into clinical diagnostic/therapeutic applications.
- **Leverage multidisciplinary collaborations** across relevant medical and scientific disciplines
- **Develop world-class physician-scientists** through formalized training programs

  --Laboratory and clinical rotation training
- **Provide hospital and community leadership** in CPR/Resuscitation.

# Translational Approach

Cellular basic science research

Translational research

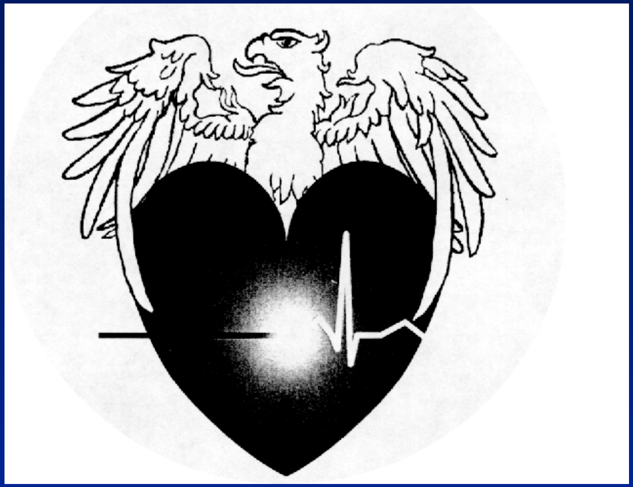
Community

Bioengineering & Biotechnology

# ERC Collaborators

- **Anesthesiology**
  - Chun-Su Yuan
- **Argonne National Labs**
  - Ken Kasza
  - Carol Giometti
- **Cardiology**
  - Beth McNally
- **Emergency Medicine**
  - James Rhee (Toxicology)
  - Tom Fisher (Health Disparities)
  - Linda Druelinger (Simulation)
- **Hospitalist Medicine**
  - Dana Edelson
- **Neurology**
  - James Brorson
- **Pediatrics**
  - Glyn Dawson
  - Jeremy Marks
- **Radiation/Oncology**
  - Howard Halpern
- **Pulmonary/Critical Care**
  - Kimm Hamann
  - Viswanathan Natarajan
  - Yimin Qin
- **Univ of Michigan**
  - Susan Stern
- **Northwestern**
  - Paul Schumacker
- **Univ of Washington**
  - Graham Nichol
- **Virginia Commonwealth University**
  - Mimi Peberde
- **Medical College Wisconsin**
  - Tom Aufderheide
- **Univ of Penn**
  - Ben Abella
  - Lance Becker
  - Raina Merchant
  - Robert Neumar
- **Industry Partners**
  - Medivance
  - Gaymar Industries
  - Laerdal
  - Philips

# ACKNOWLEDGEMENTS



Ben Abella
Jason Alvarado
Travis Anderson
David Beiser
Wei-Tien Chang
Chang-Qing Li

Juan Li
Yimin Qin
Zuo-Hui Shao
Huashan Wang
Kim Wojcik
Danhong Zhao

Xinmin Li
Lance Becker
Kimm Hamann
Paul Schumacker
Sue Stern