CPR: Stuff You're Not Supposed to Know Yet...

Presented at EMS Today

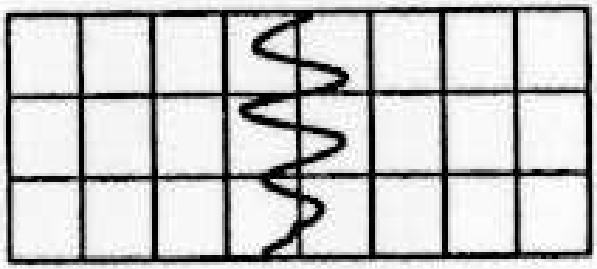
March 20, 2005

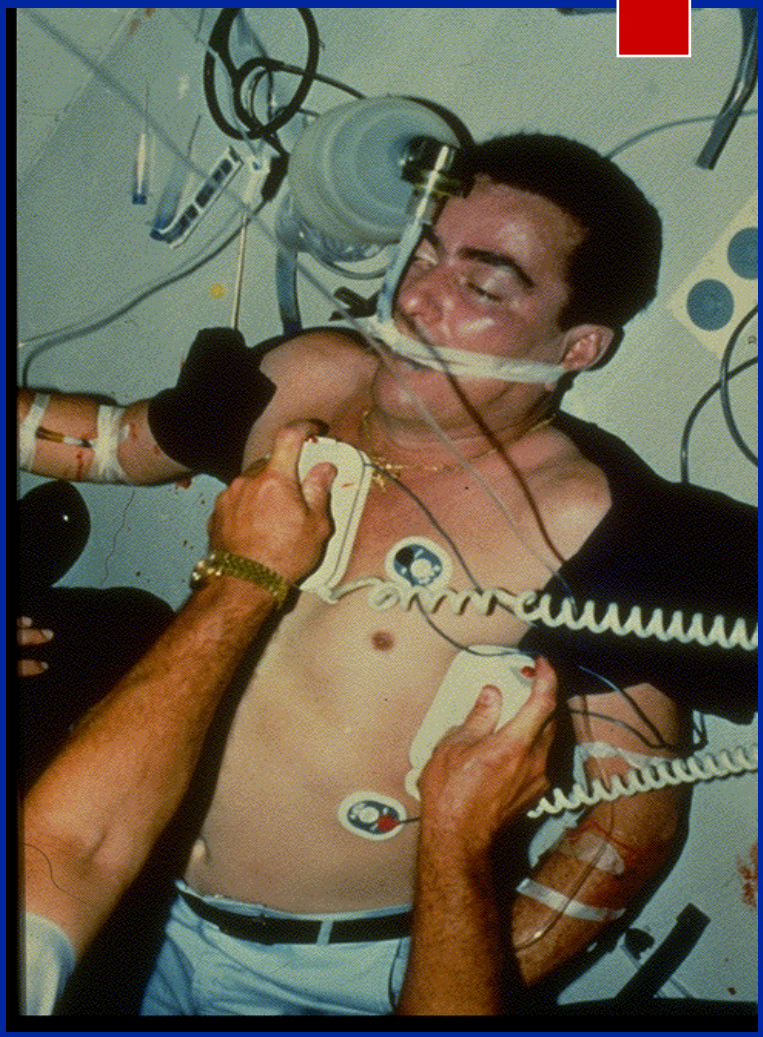
by Ray Fowler, MD, FACEP

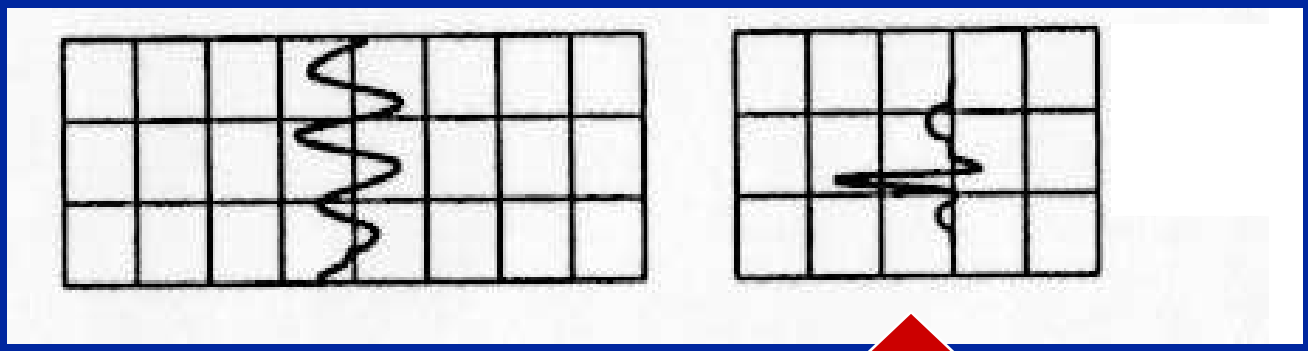
for Dr. Paul Pepe

1 of Every 5 Persons Who Die in the the U.S. ...

.....Will Die From Sudden Death Syndrome….



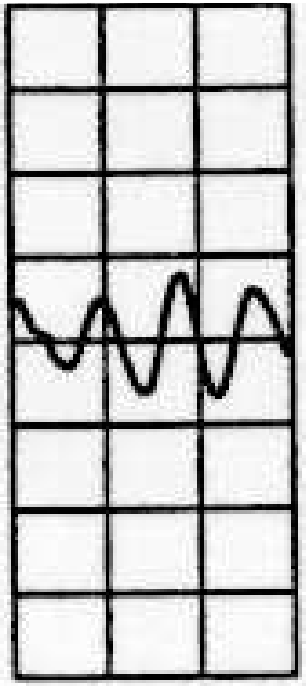




The Problem ...

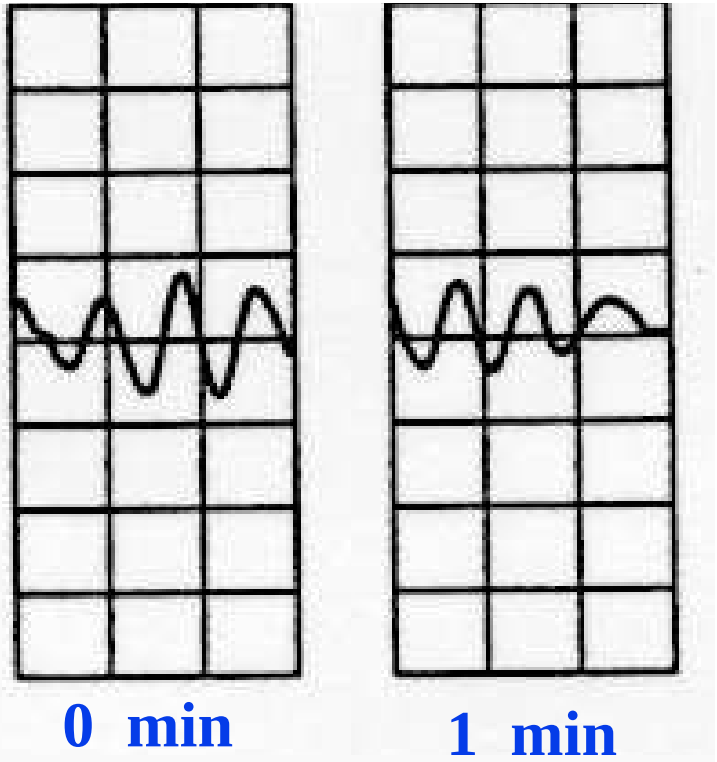
Ventricular Fibrillation

… is not a static process



0 min

Electrical Deterioration of Ventricular Fibrillation



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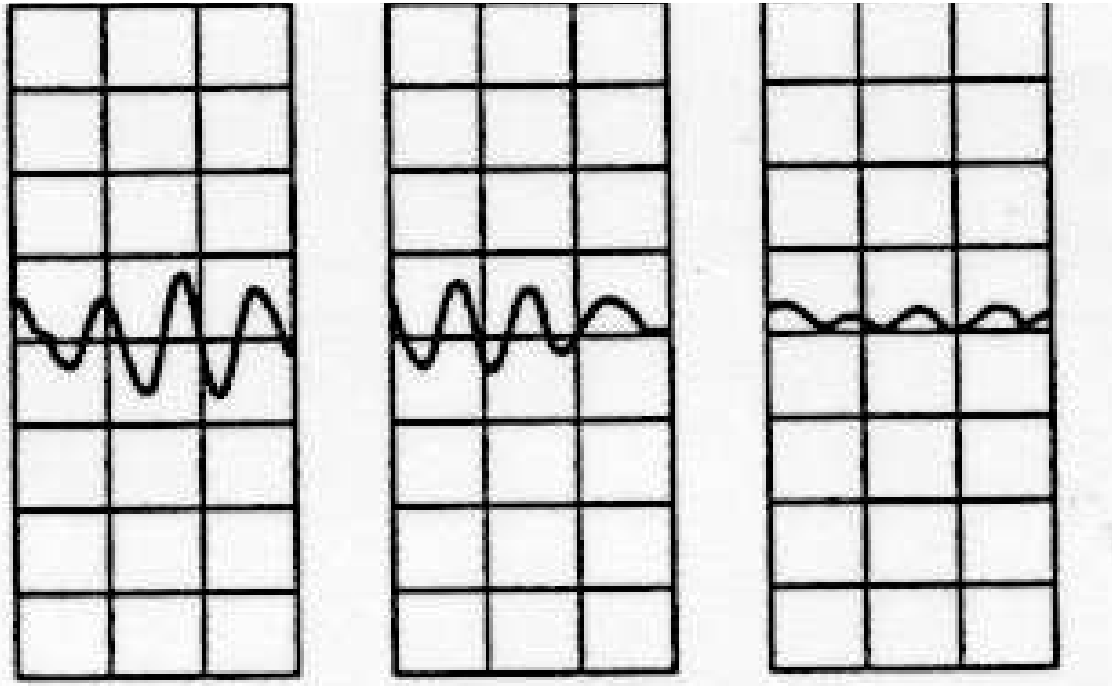

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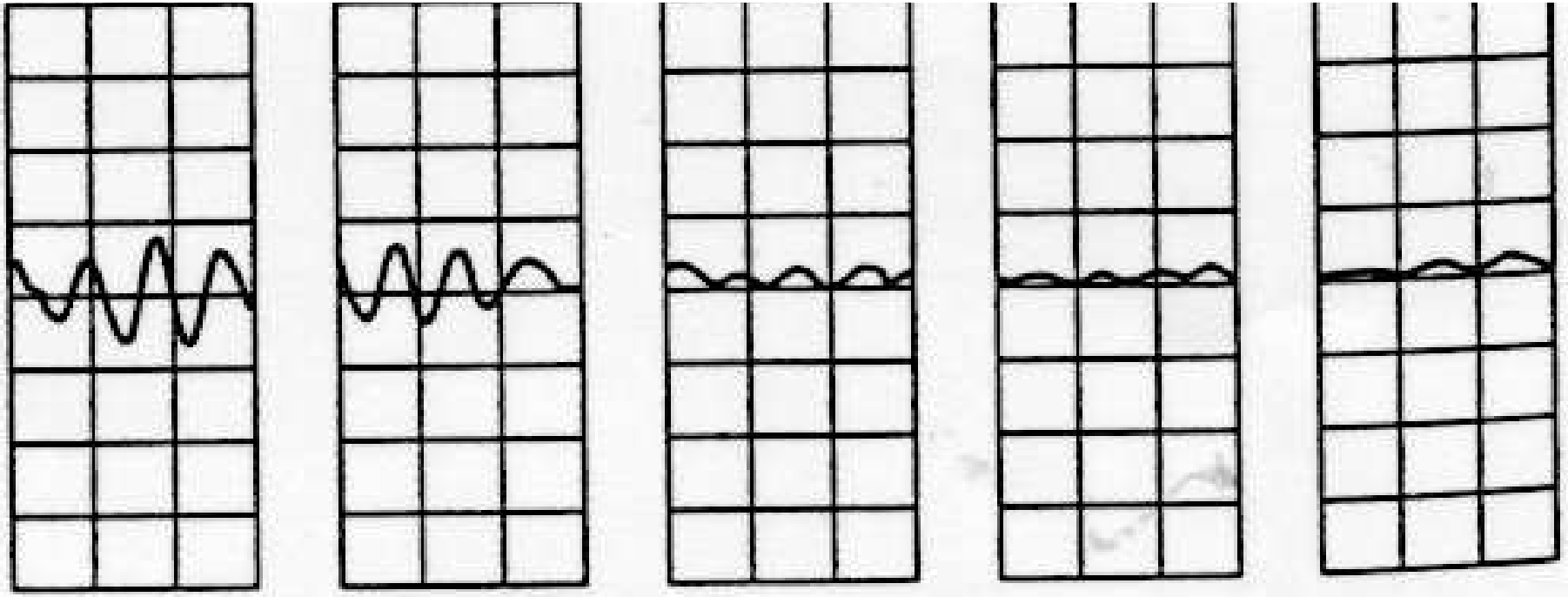

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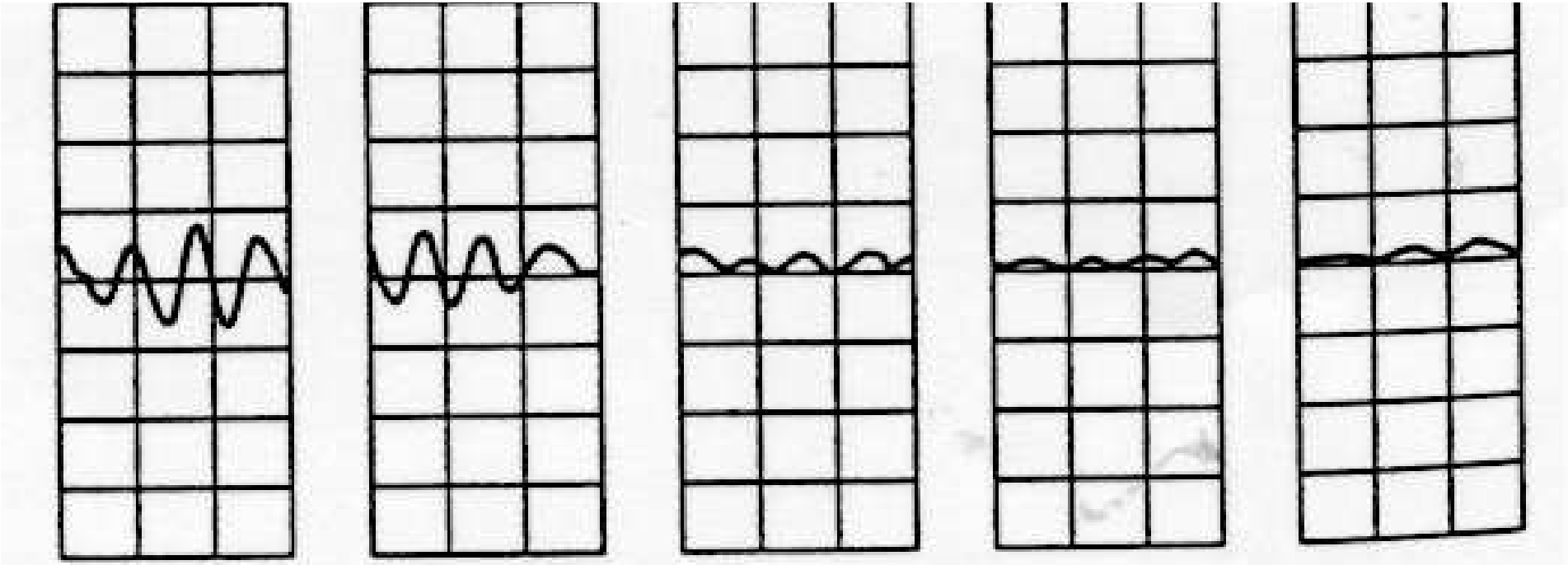
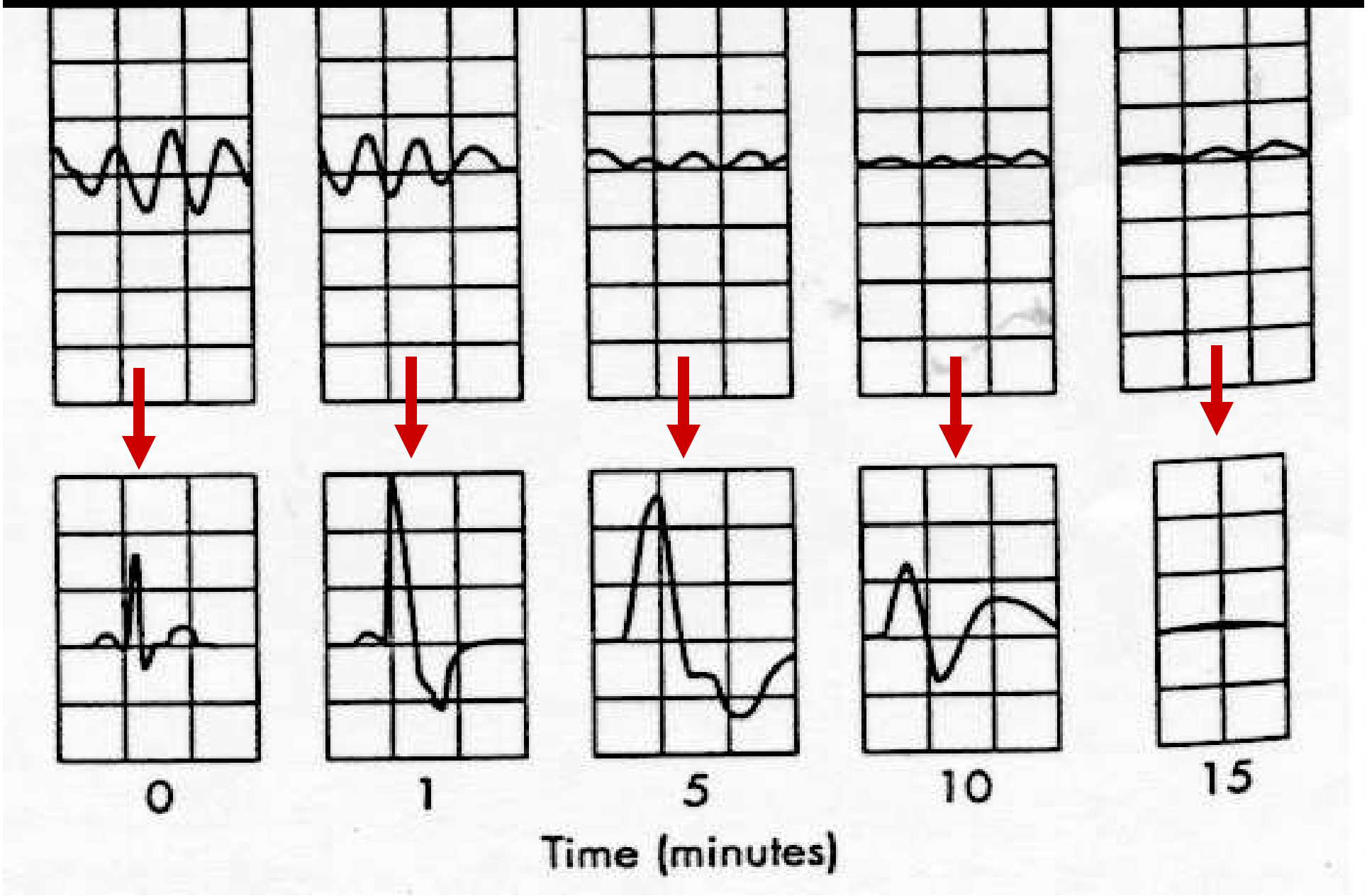


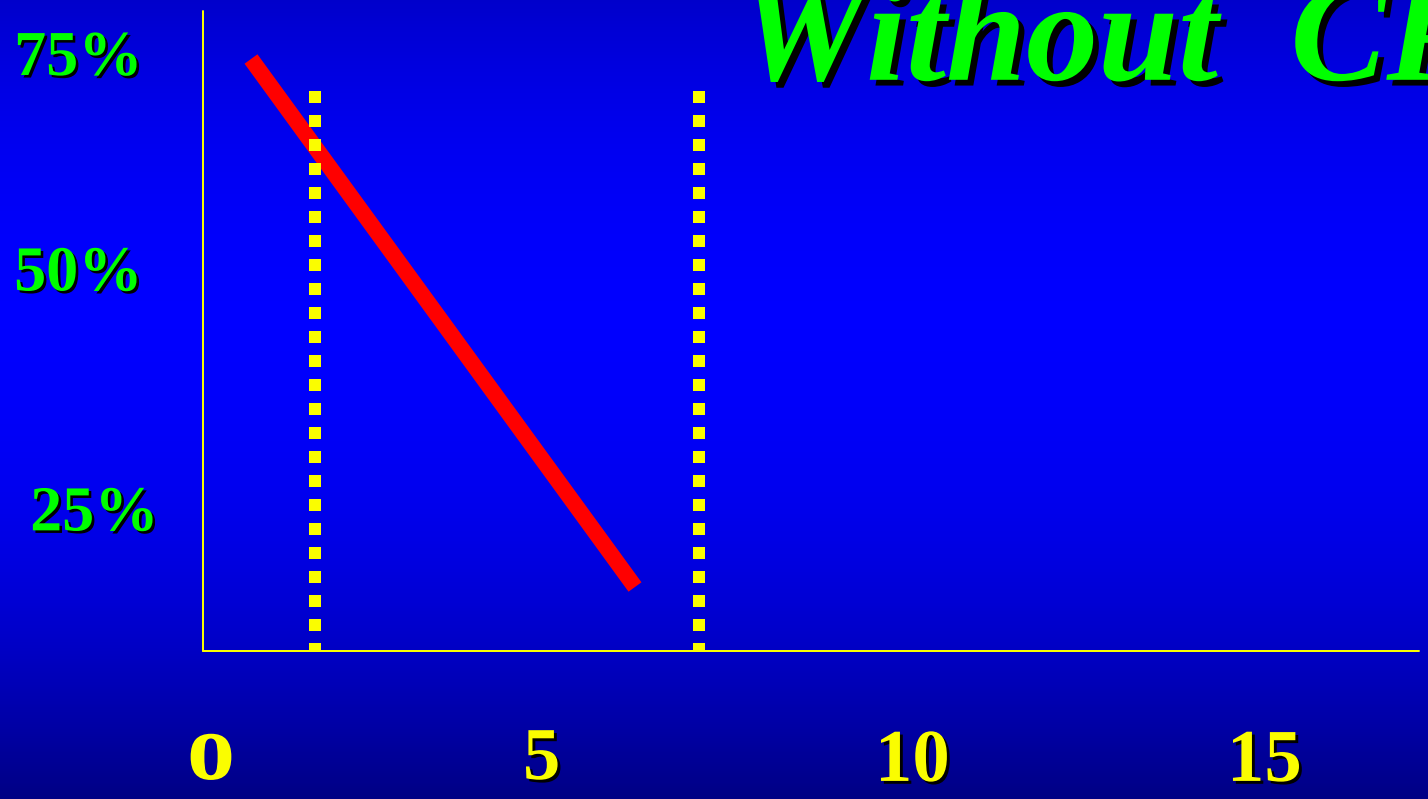
Electrical Deterioration of Ventricular Fibrillation

= Depletion of Myocardial Energy Stores (ATP Depletion)

Anticipated Post-Defibrillation Rhythms

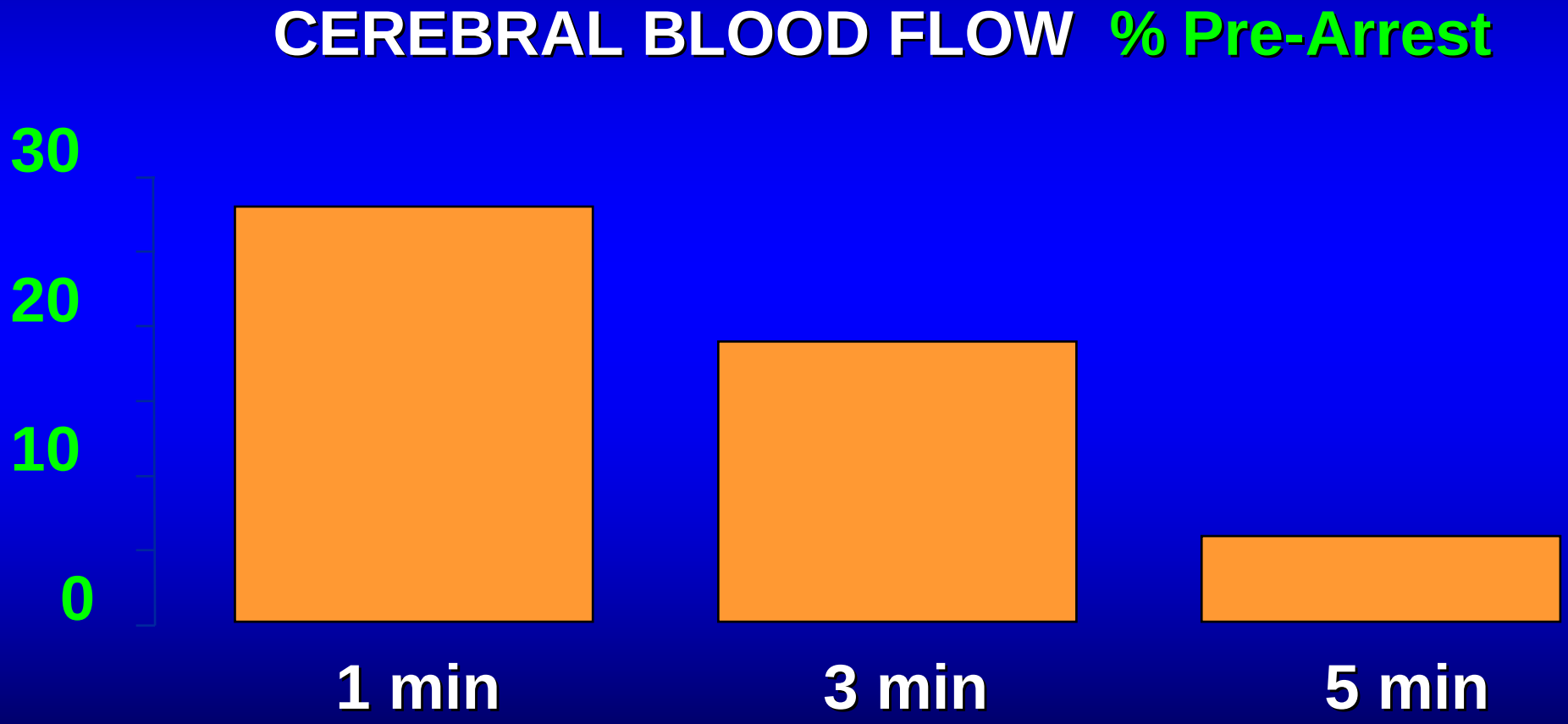


VFib Survival Rates



Time to CPR and Cortical Blood Flow

in Rabbits Lee SK, et al, *Resuscitation* 1989;17:105

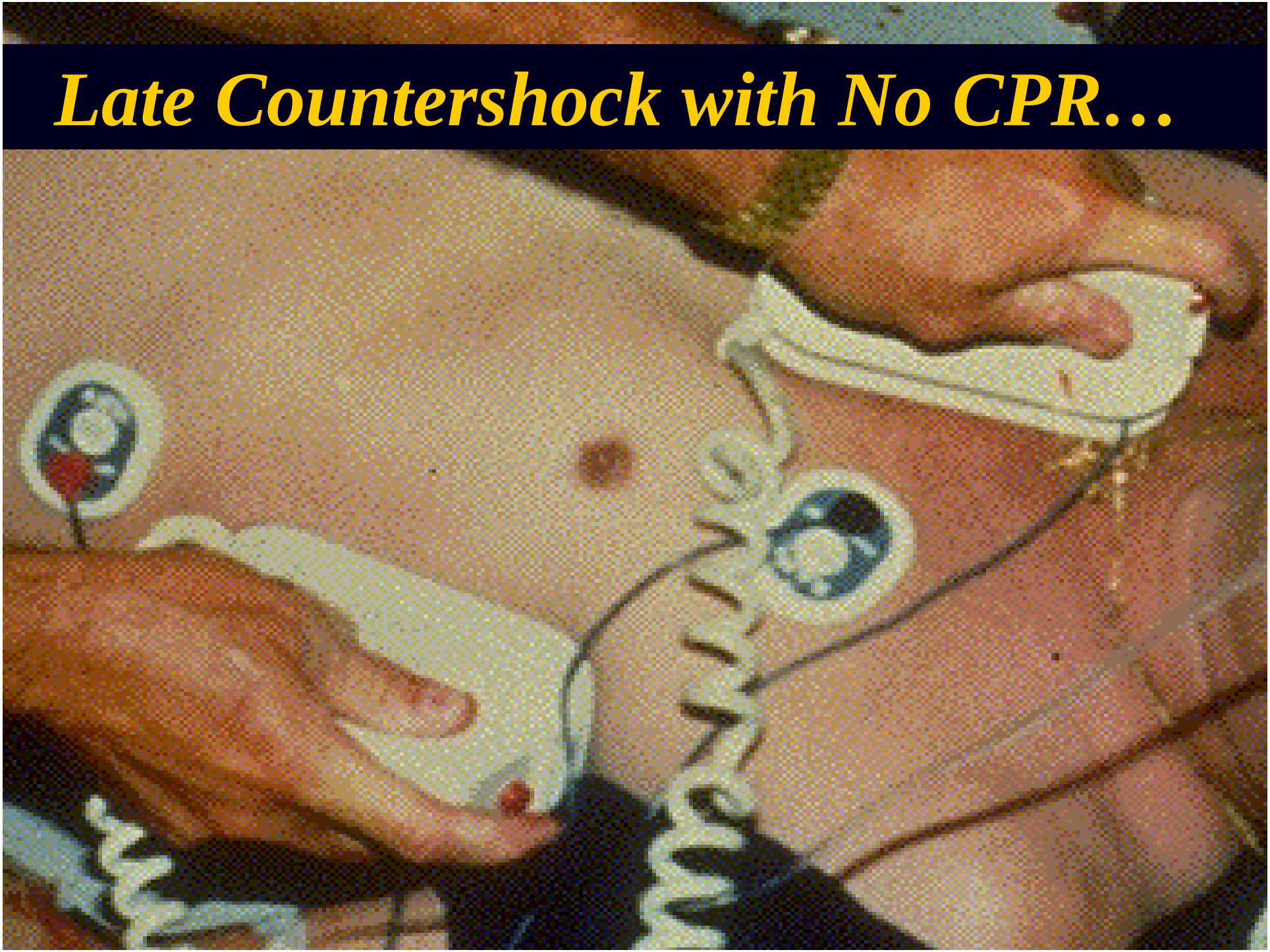


But …

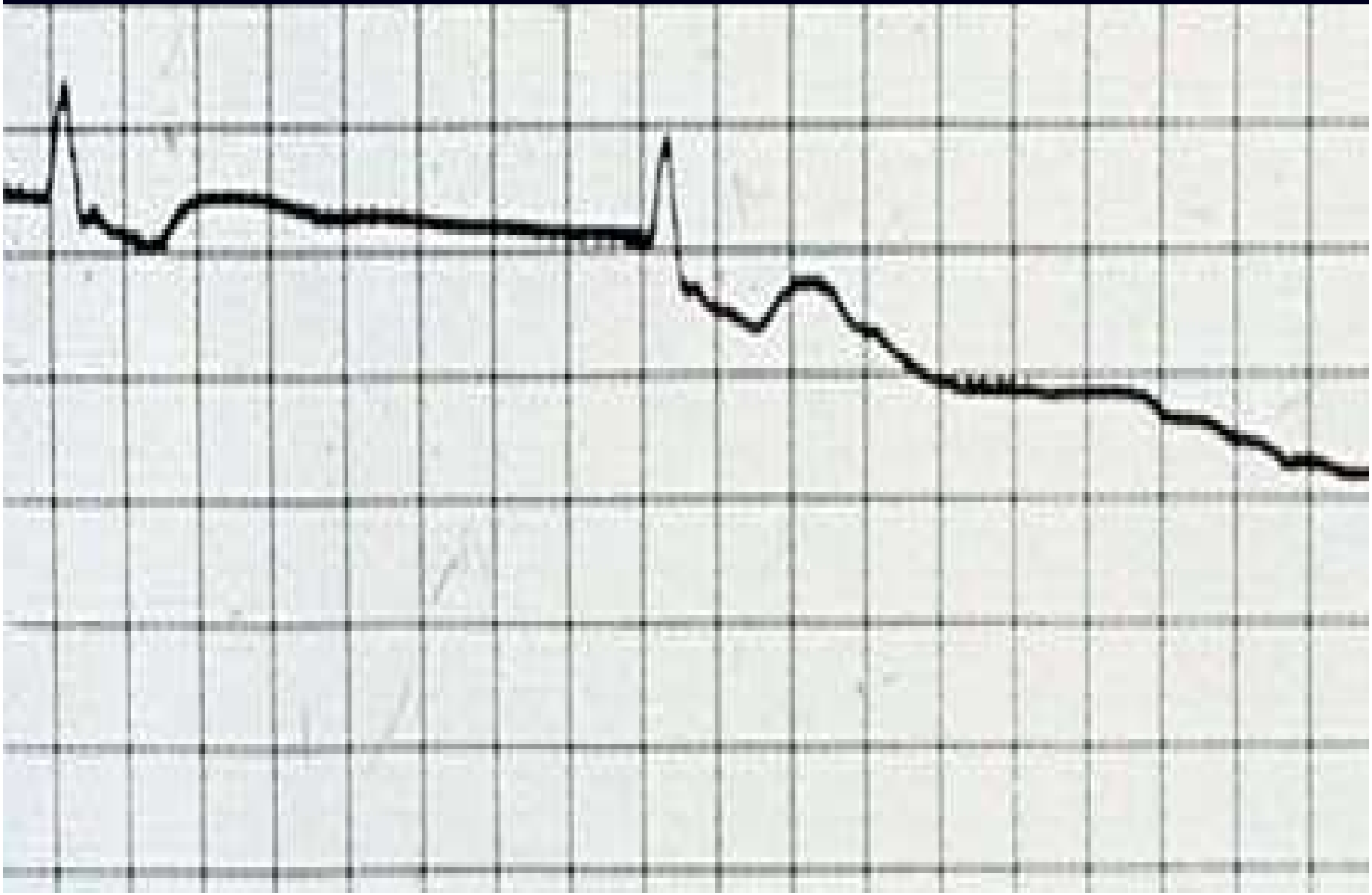
In most places…

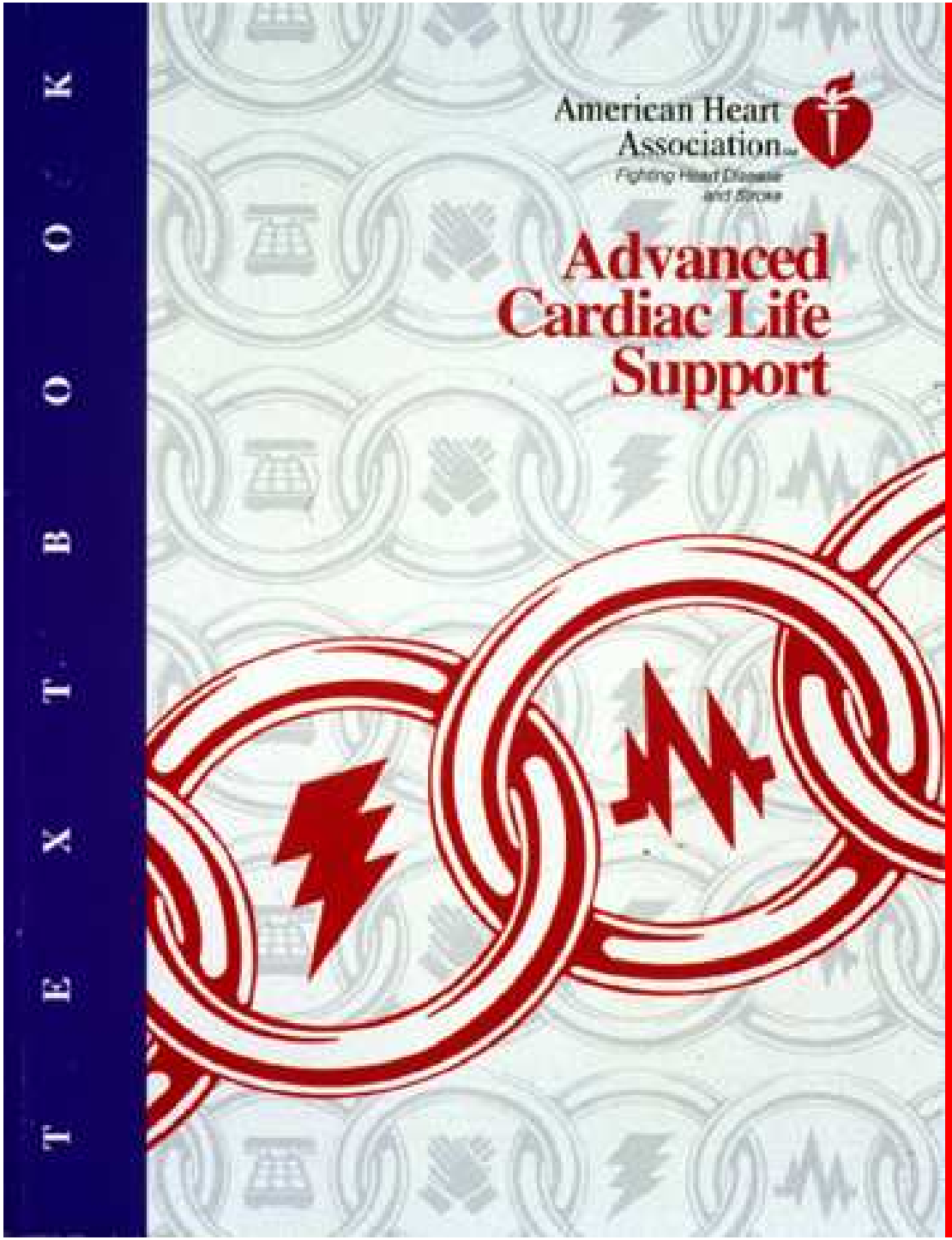
… Bystander CPR Infrequent

Late Countershock with No CPR…



Post-Countershock Rhythm ...



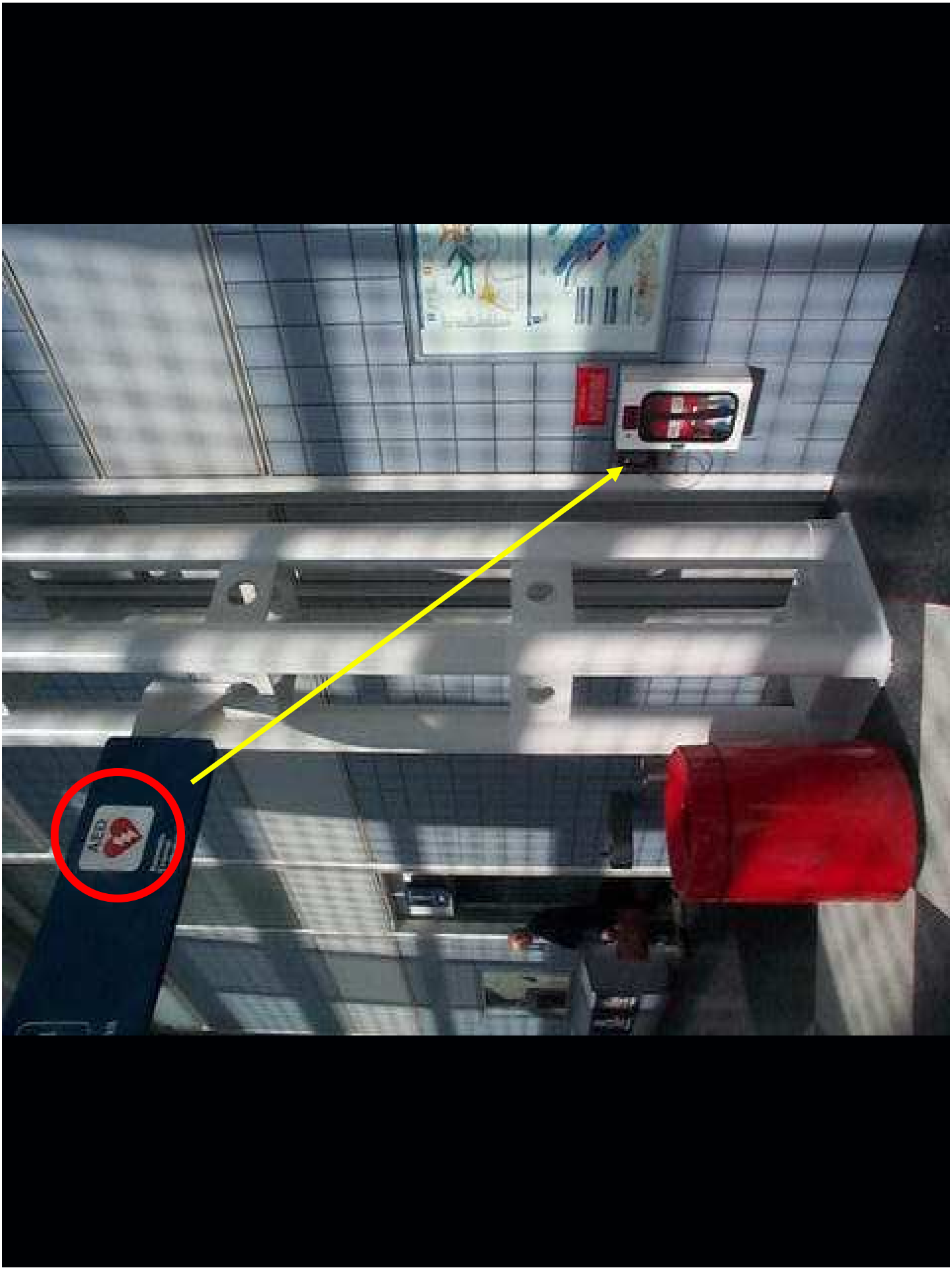


So We Try "ACLS"

i.e, Drugs, Endotracheal Intubation

High Dose Epinephrine Trials...

...No Advantage Demonstrated



Current Approach to Ventricular Fibrillation

Shock It !

... As Soon As Possible !!!

Chicago Airport

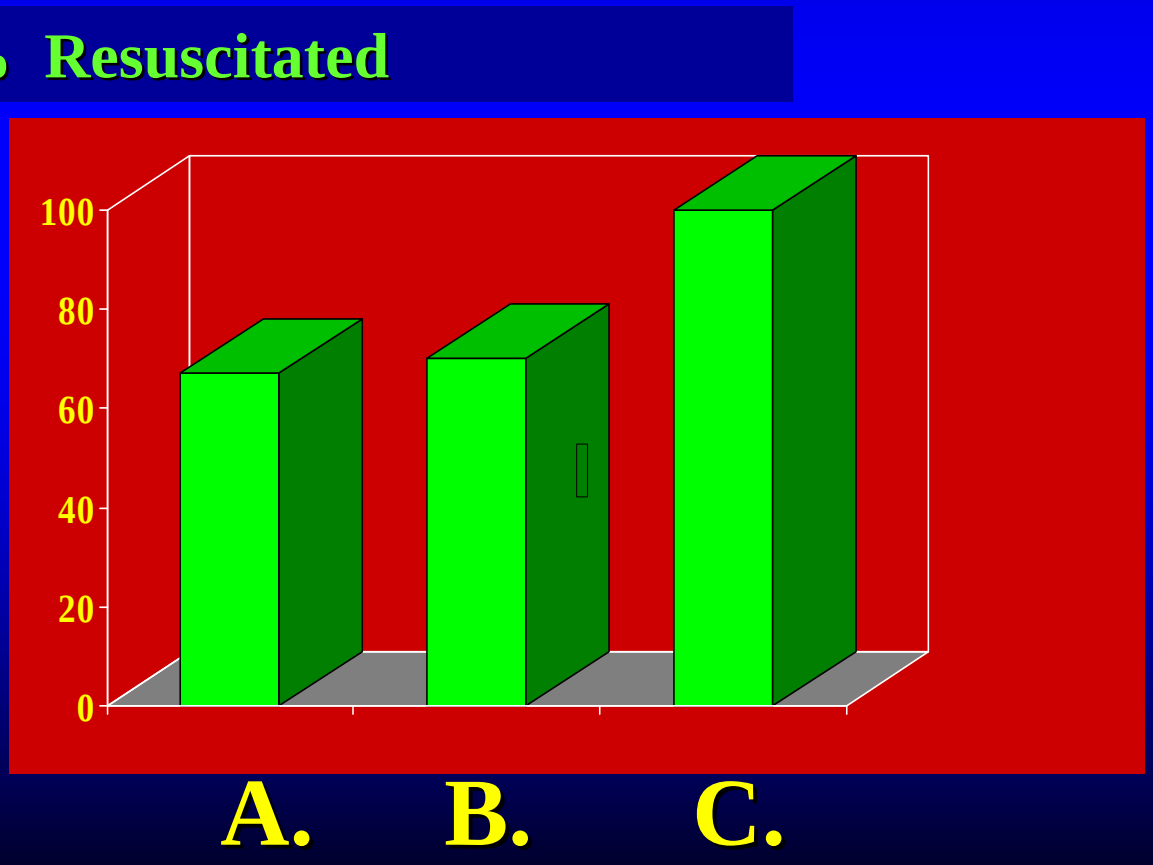
1st Year's Experience: ***14 Arrests (13 VF)***

Of 9 VF Cases, Without Delay...

- ***All 9 (100%) Saved***
- ***Waking Before EMS***
- ***6 Never Saw an AED***

Treatment after 1 min. of V.F.

Yakaitas (1980)



A. Epinephrine, Airway, CPR and Then Shock

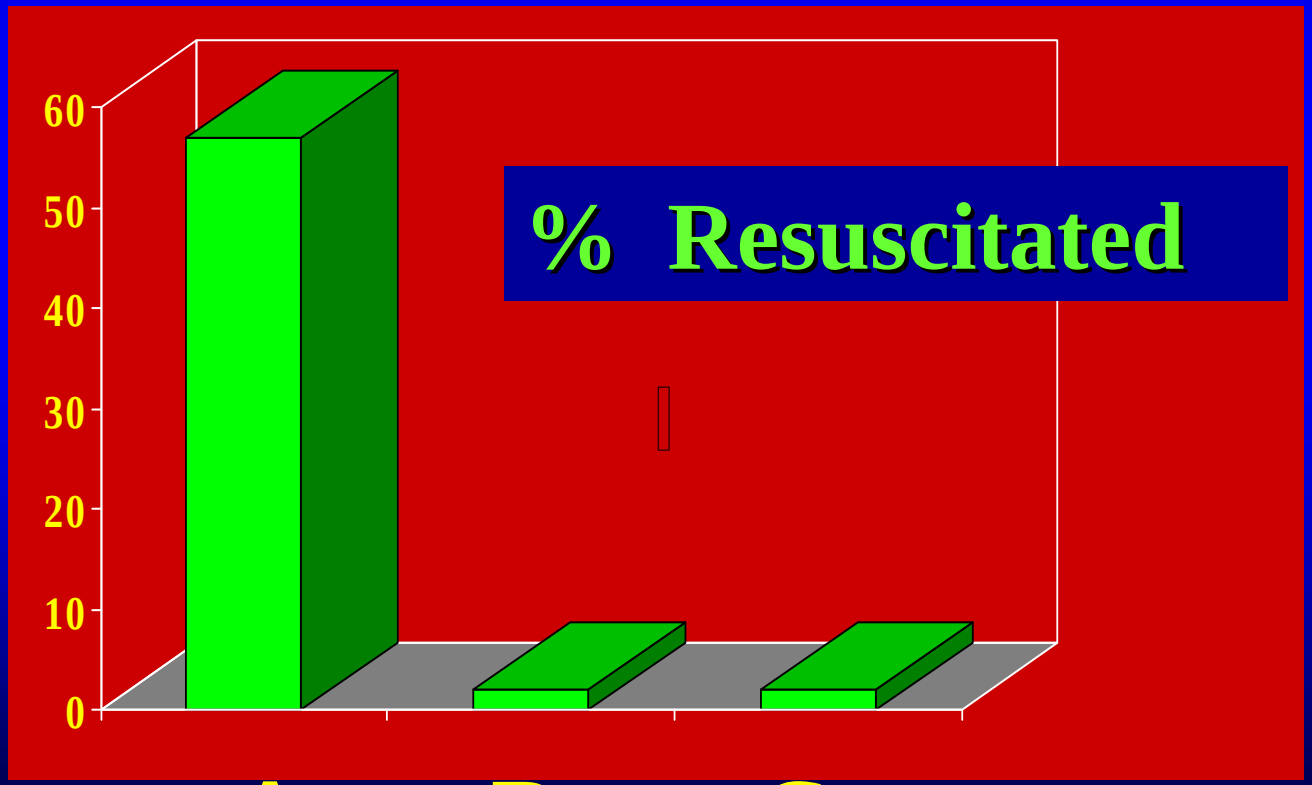
B. Airway, CPR & Shock

C. Shock Only

But...

Treatment after 5 min of V.F.

Yakaitas (1980)

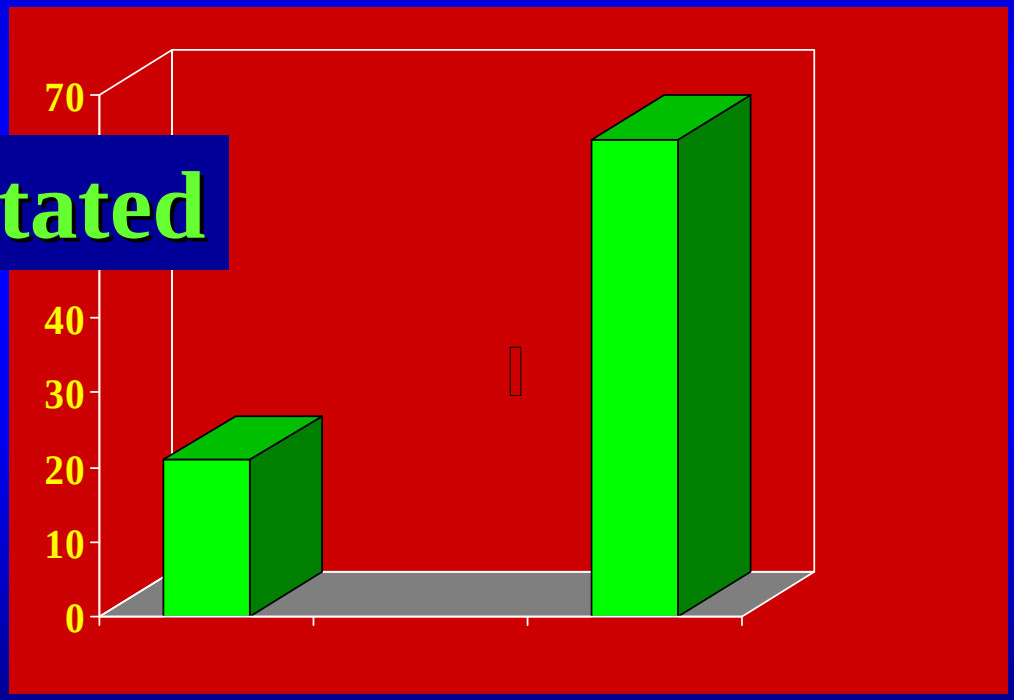


A. Epinephrine, Airway, CPR, & Then Shock

B. Airway, CPR & Shock

C. Shock Only

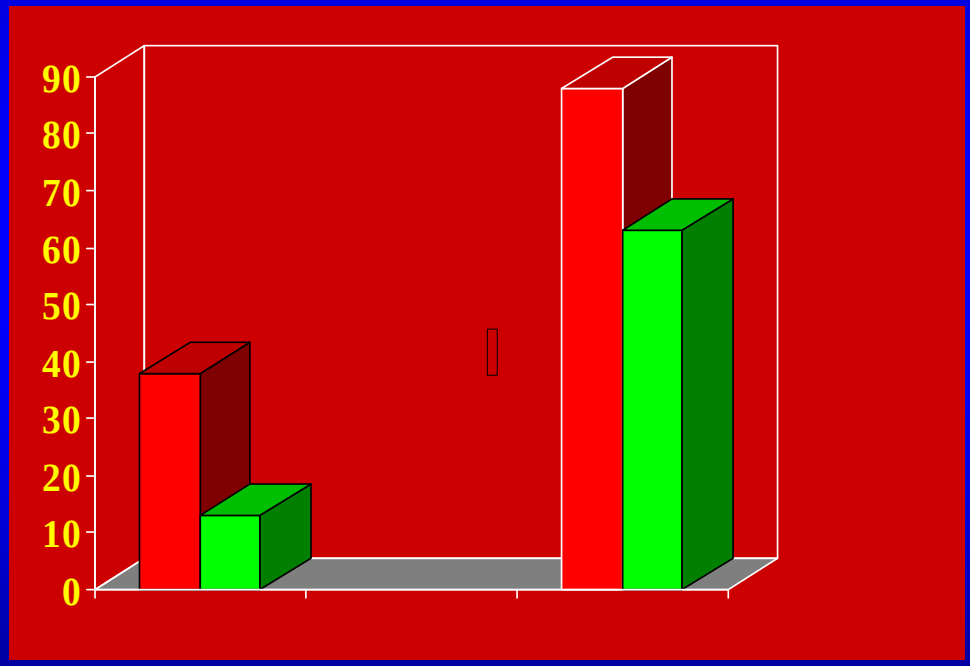
Treatment after 7.5 min of V.F. *Neimann (1992)*



Treatment after 8 min of V.F.

Menegazzi (1993)

% Resuscitated
% Surviving



Pig Model
1 hour survival

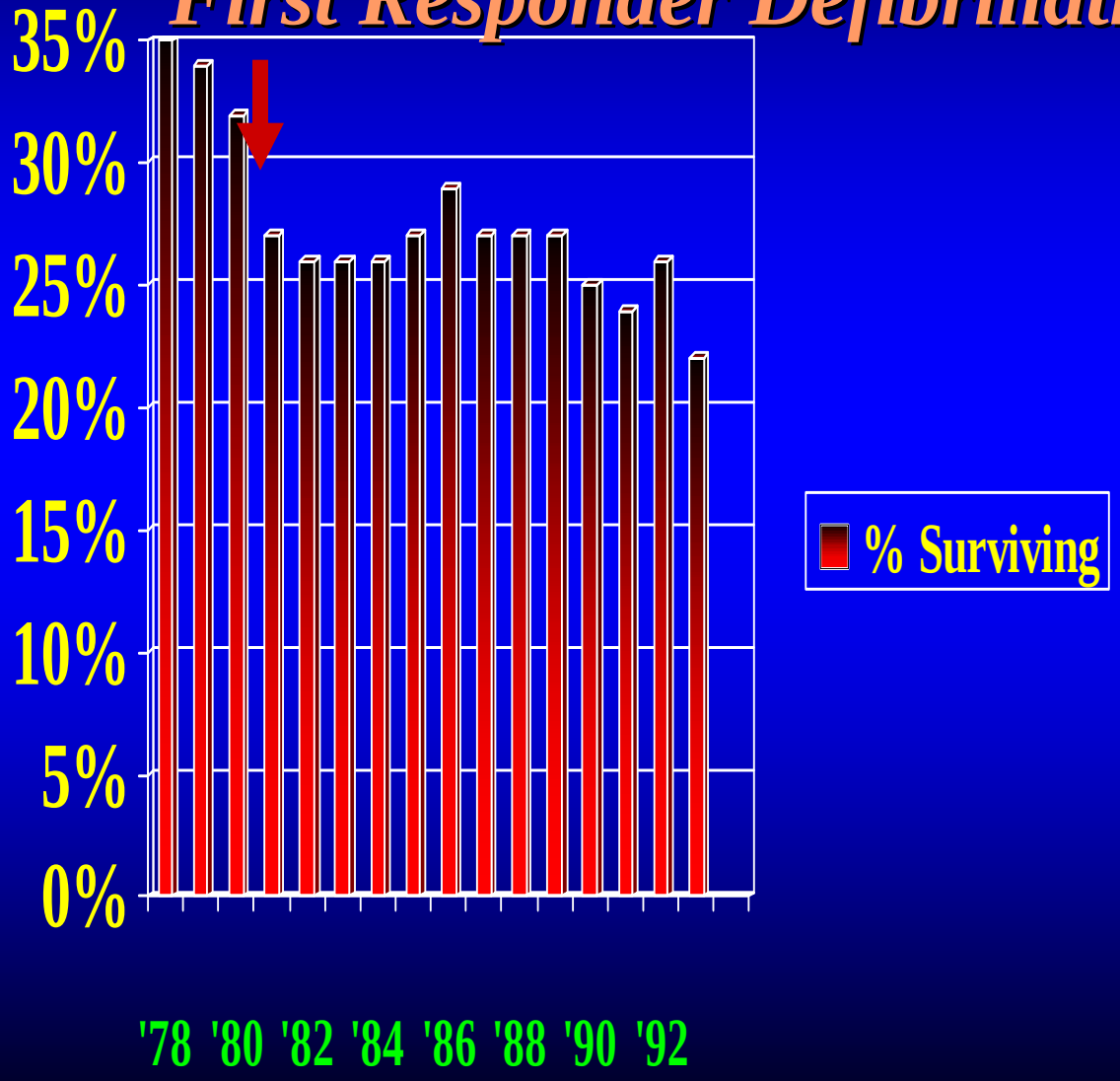
Shock First

Drugs First
(WITH hyperventilation)

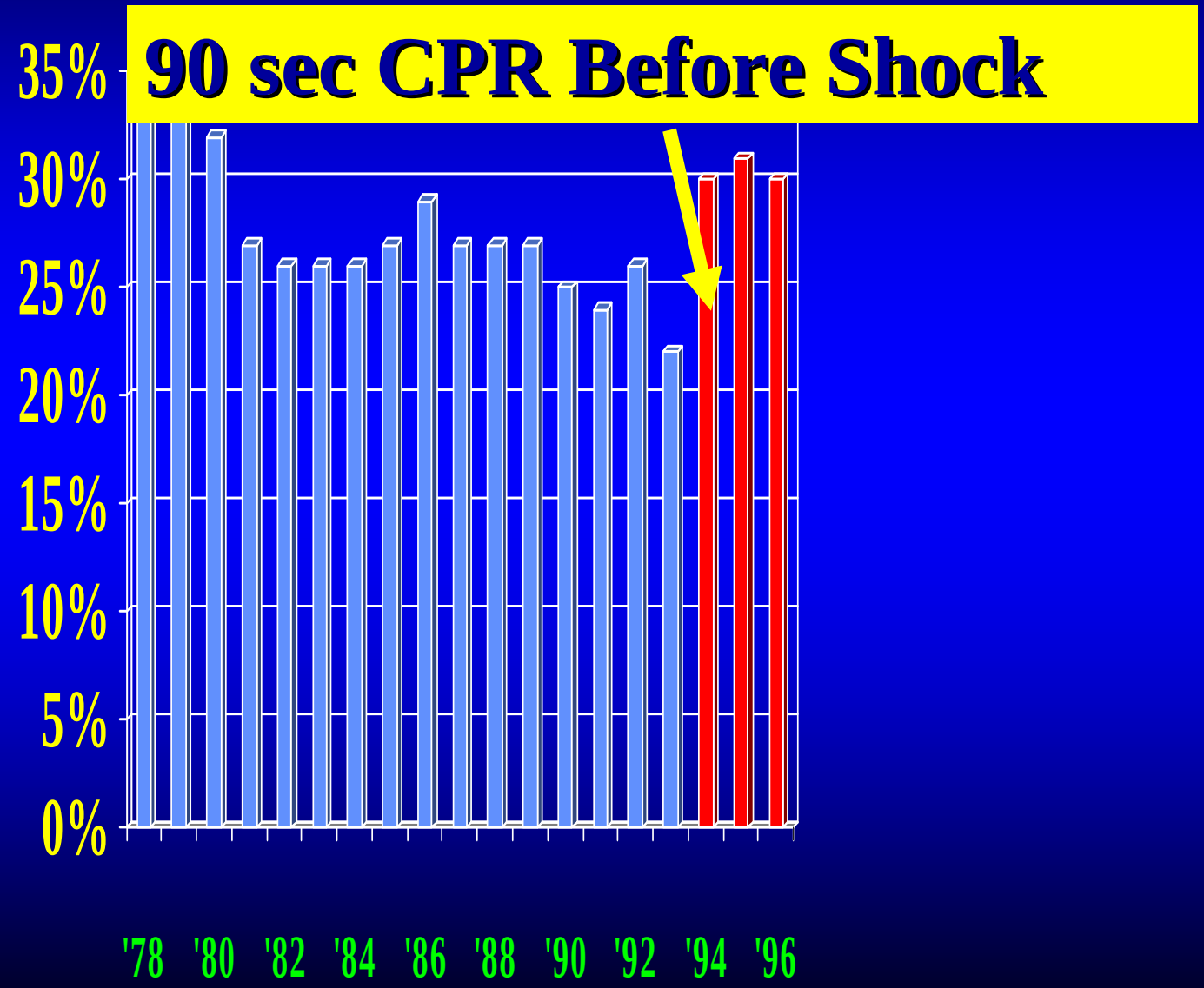
Cobb, et al *(JAMA, 1999)...*

VF Survival Rates in Seattle

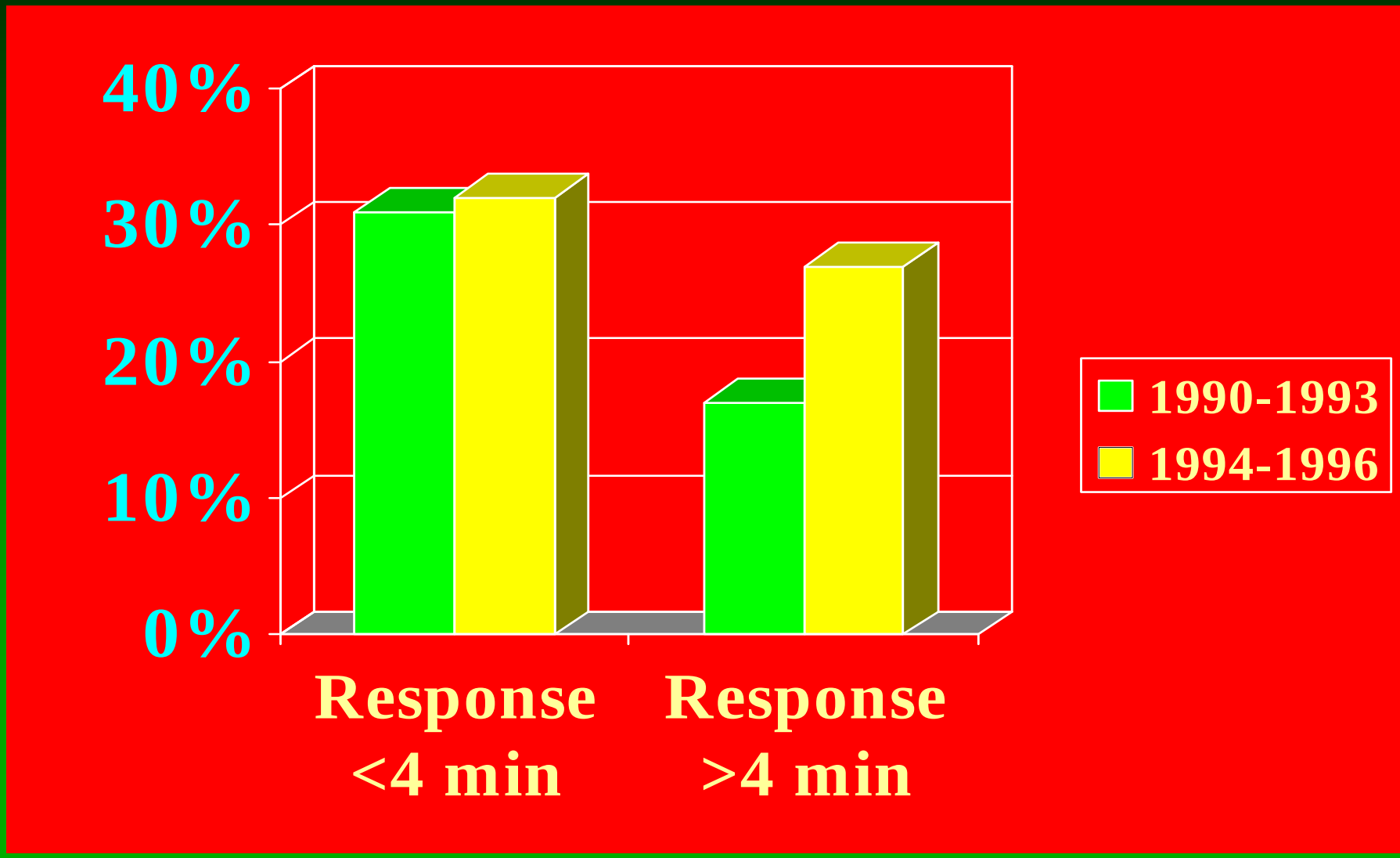
First Responder Defibrillation



VF Survival Rates in Seattle



VF Survival Rates in Seattle



Lars Wik, et al...

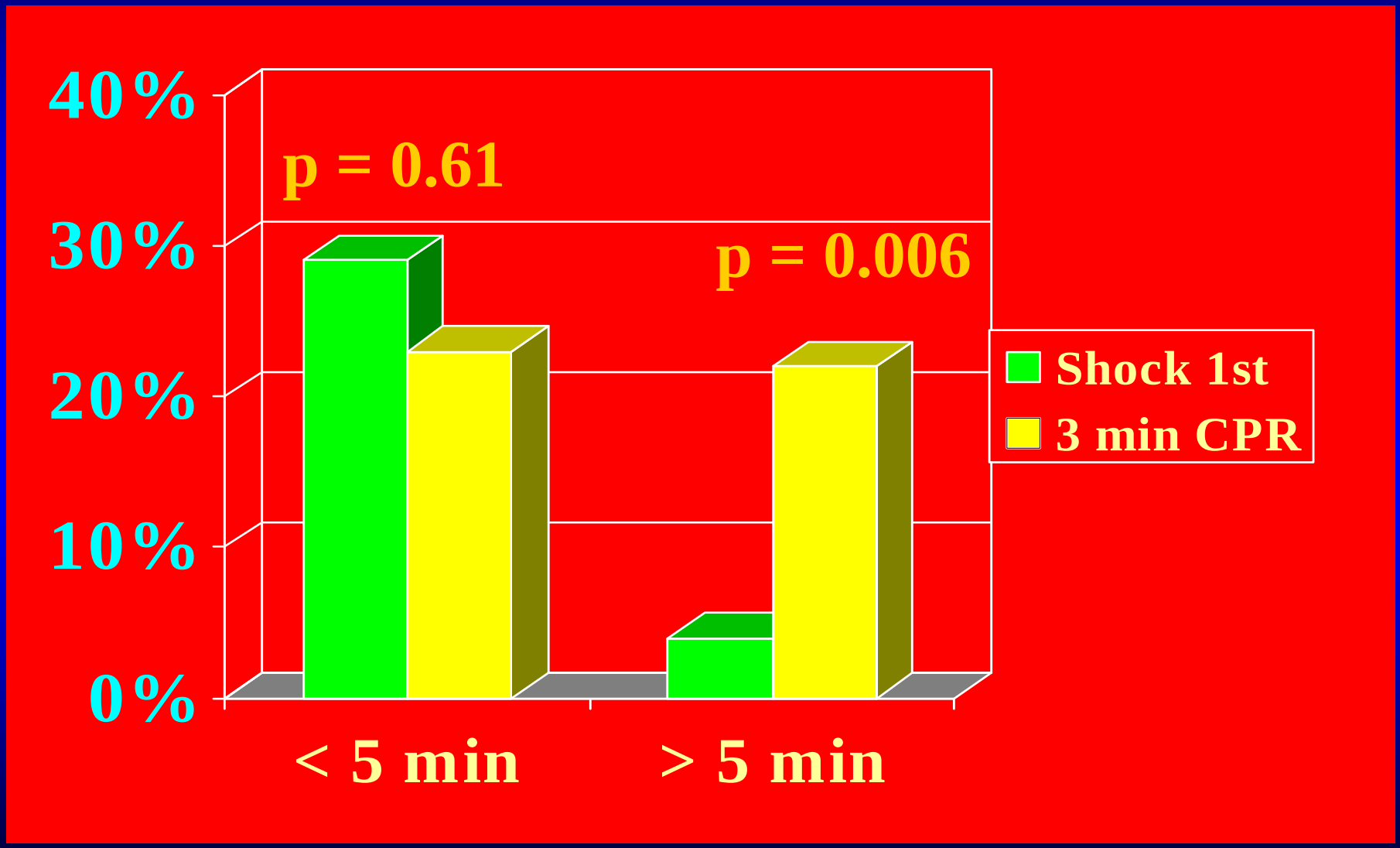
Controlled Study:

3 min of CPR

Prior to Defib Attempts…

= Increased Survival !

VF Survival Rates in Oslo



So...

Should We Always Give CPR and Drugs First?

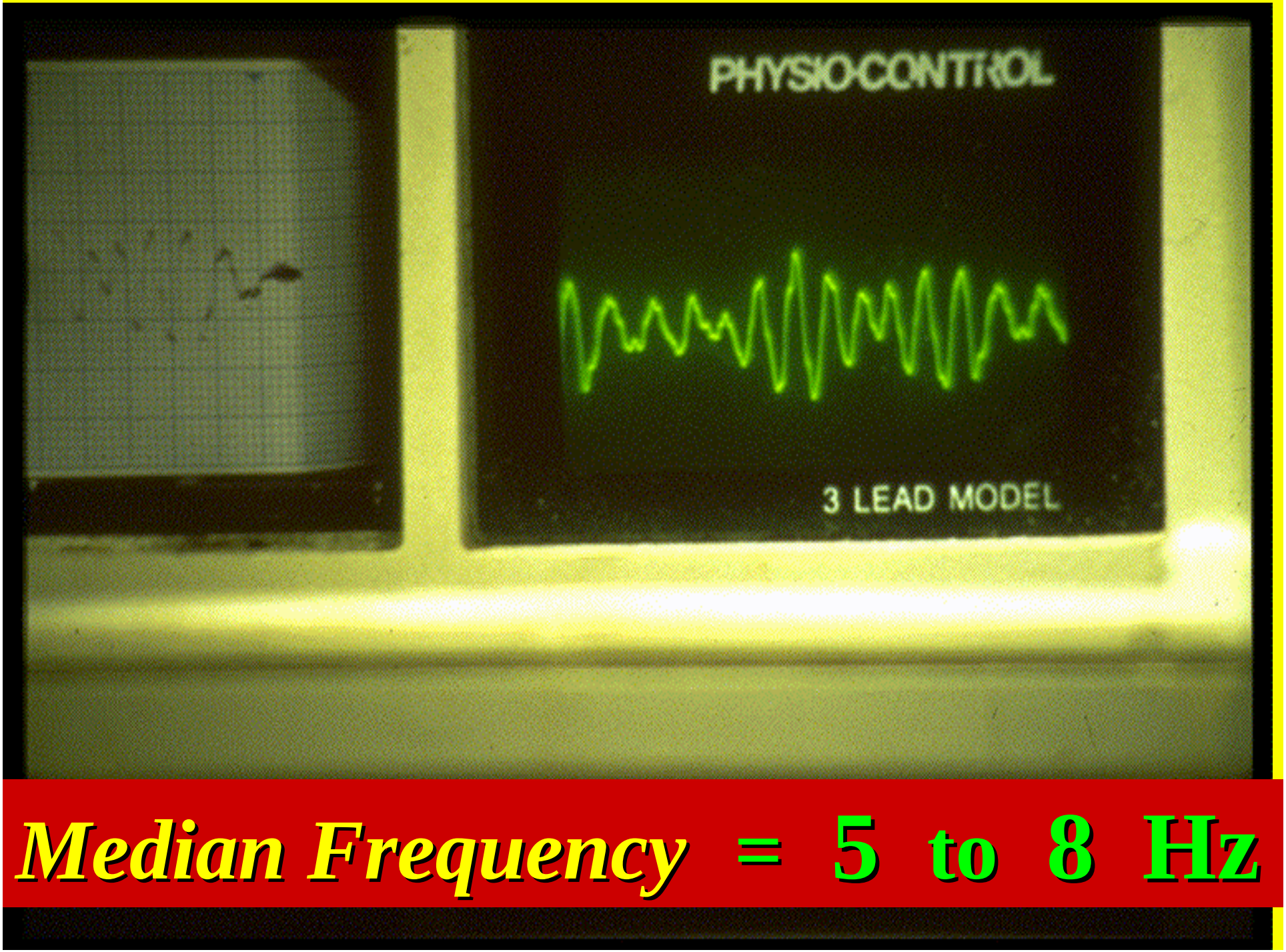
Maybe Not...

The ECG Signal

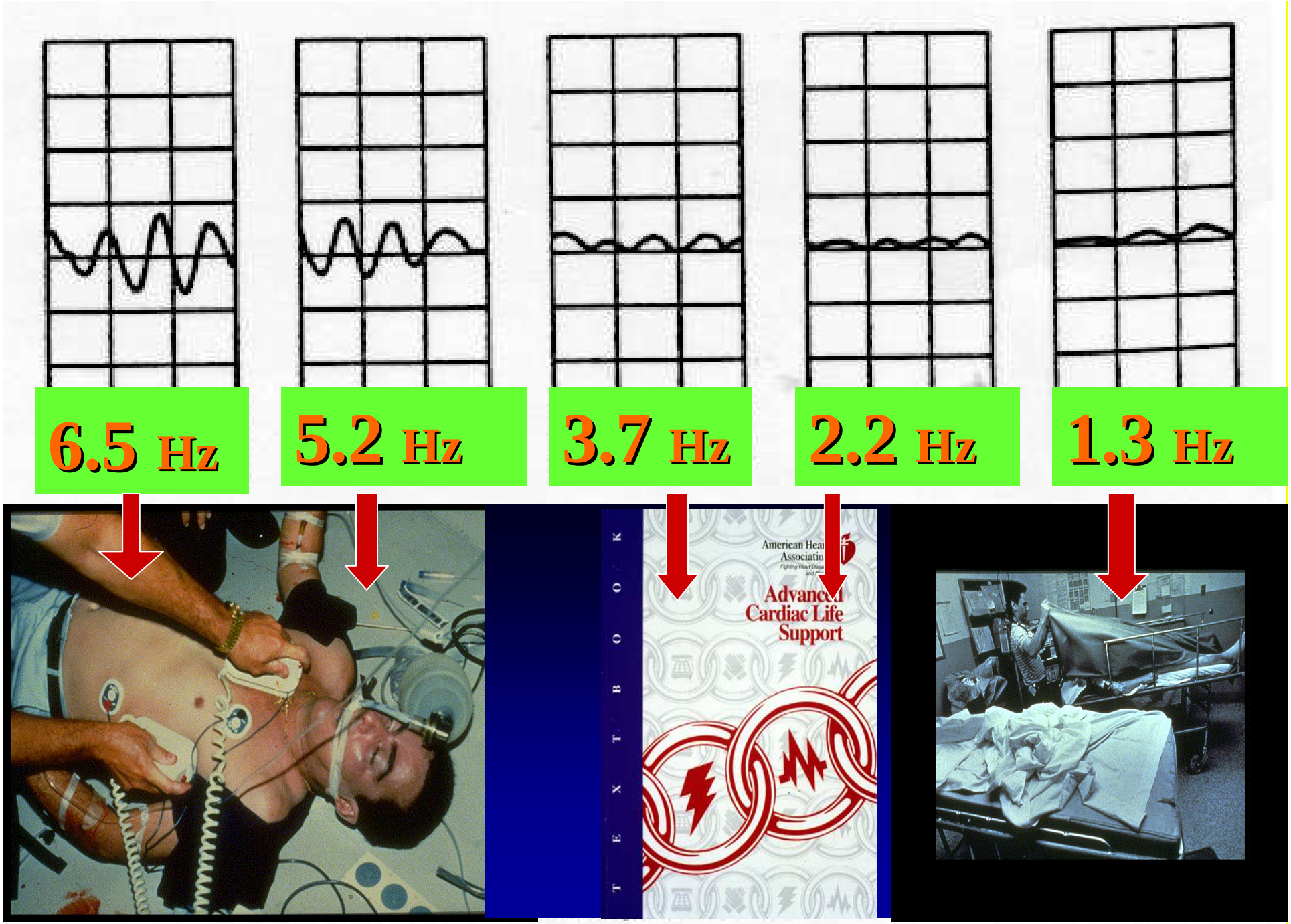
...Can Be Correlated with Myocardial Energy Supplies

eg. Median Frequency

or Fractile Dimensions



***Median Frequency* = 5 to 8 Hz**



Limitations...

- *Not Yet Tested*
- *Median Frequency?*
- *Monophasic Shock*

In Summary

Immediate Countershock is Clearly Good…

…But Other Things May Need to Be Done First after Prolonged VF….

Is Ventilation Really Necessary ?

In very low flow states

Oxygen Consumption

Becomes Dependent on

Oxygen Delivery...

For Example, CPR Cases...

Cardiac Arrest

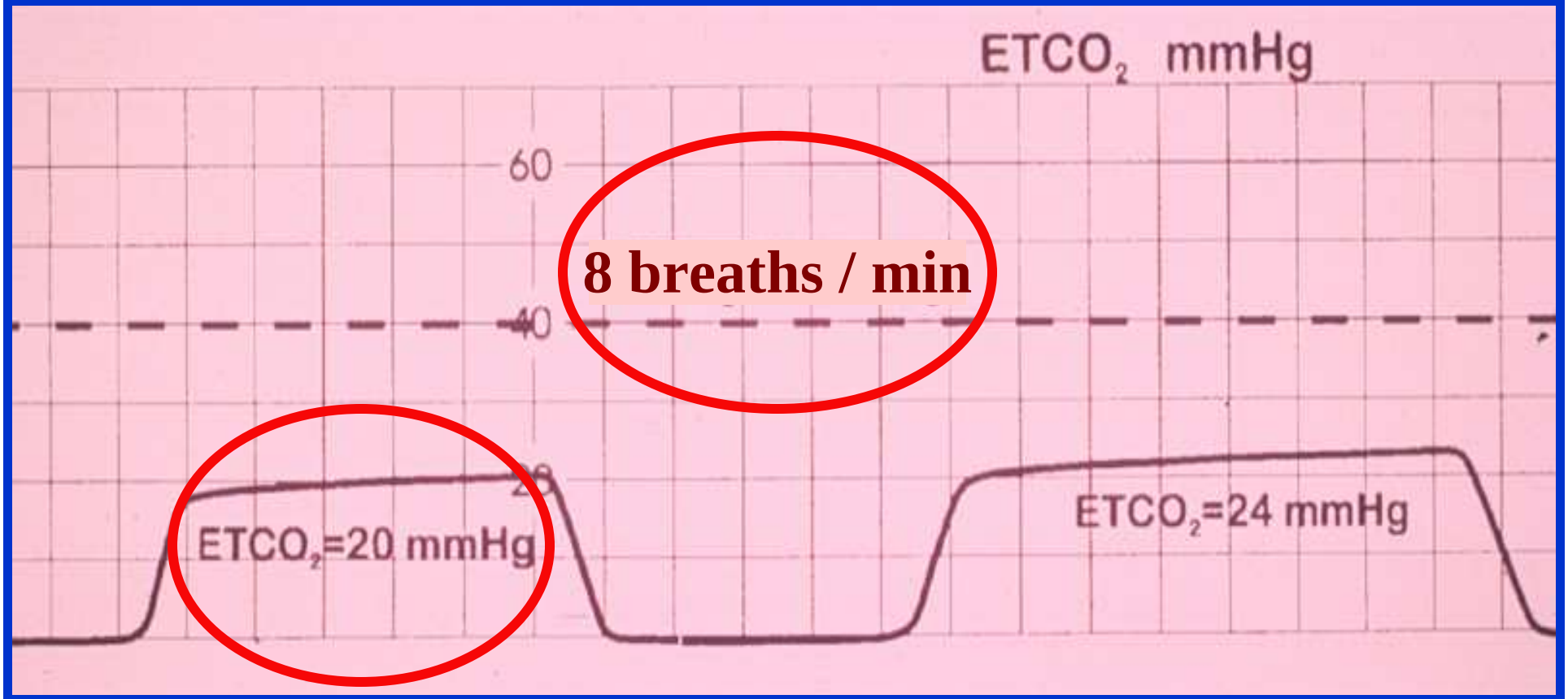
- Little O_2 Delivery & Consumption
- Little CO_2 Production & Venous Return

...Little Need to Ventilate

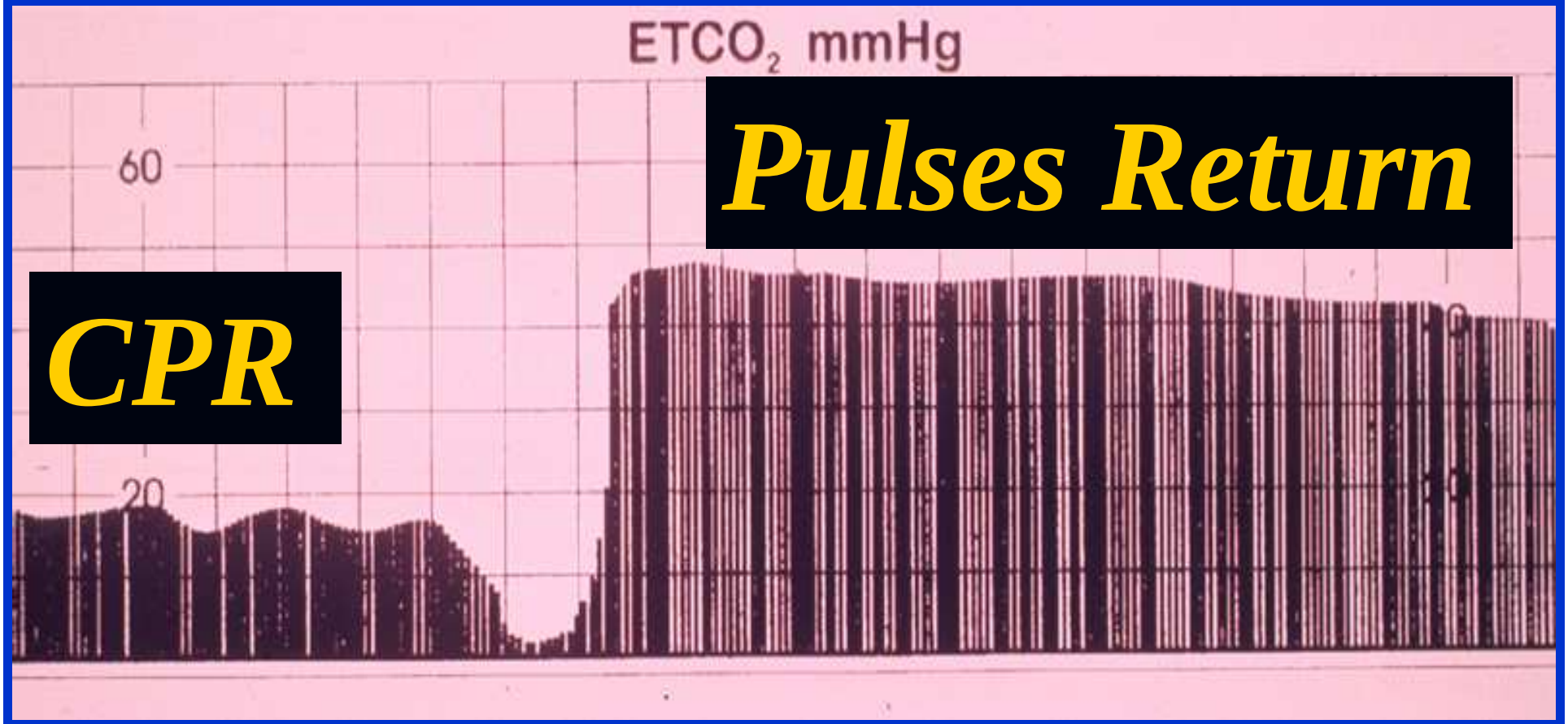
CO_2 Production

Largely Dependent on Oxygen Consumption

Cardiac Arrest….



…Little CO_2 Excretion



Take Home…

Ventilation Should Match Perfusion…

Hyperventilation-Induced Hypotension During Cardiopulmonary Resuscitation

Tom P. Aufderheide, MD; Gardar Sigurdsson, MD; Ronald G. Pirrallo, MD, MHSA; Demetris Yannopoulos, MD; Scott McKnite, BA; Chris von Briesen, BA, EMT; Christopher W. Sparks, EMT; Craig J. Conrad, RN; Terry A. Provo, BA, EMT-P; Keith G. Lurie, MD

Background—A clinical observational study revealed that rescuers consistently hyperventilated patients during out-of-hospital cardiopulmonary resuscitation (CPR). The objective of this study was to quantify the degree of excessive ventilation in humans and determine if comparable excessive ventilation rates during CPR in animals significantly decrease coronary perfusion pressure and survival.

Methods and Results—In humans, ventilation rate and duration during CPR was electronically recorded by professional rescuers. In 13 consecutive adults (average age, 63±5.8 years) receiving CPR (7 men), average ventilation rate was 30±3.2 per minute (range, 15 to 49). Average duration per breath was 1.0±0.07 per second. No patient survived. Hemodynamics were studied in 9 pigs in cardiac arrest ventilated in random order with 12, 20, or 30 breaths per minute. Survival rates were then studied in 3 groups of 7 pigs in cardiac arrest that were ventilated at 12 breaths per minute (100% O_2), 30 breaths per minute (100% O_2), or 30 breaths per minute (5% CO_2/95% O_2). In animals treated with 12, 20, and 30 breaths per minute, the mean intrathoracic pressure (mm Hg/min) and coronary perfusion pressure (mm Hg) were 7.1±0.7, 11.6±0.7, 17.5±1.0 ($P<0.0001$), and 23.4±1.0, 19.5±1.8, and 16.9±1.8 ($P=0.03$), respectively. Survival rates were 6/7, 1/7, and 1/7 with 12, 30, and 30+ CO_2 breaths per minute, respectively ($P=0.006$).

Conclusions—Professional rescuers were observed to excessively ventilate patients during out-of-hospital CPR. Subsequent animal studies demonstrated that similar excessive ventilation rates resulted in significantly increased intrathoracic pressure and markedly decreased coronary perfusion pressures and survival rates. **(*Circulation*. 2004;109: 1960-1965.)**

Aufderheide Study of Paramedics

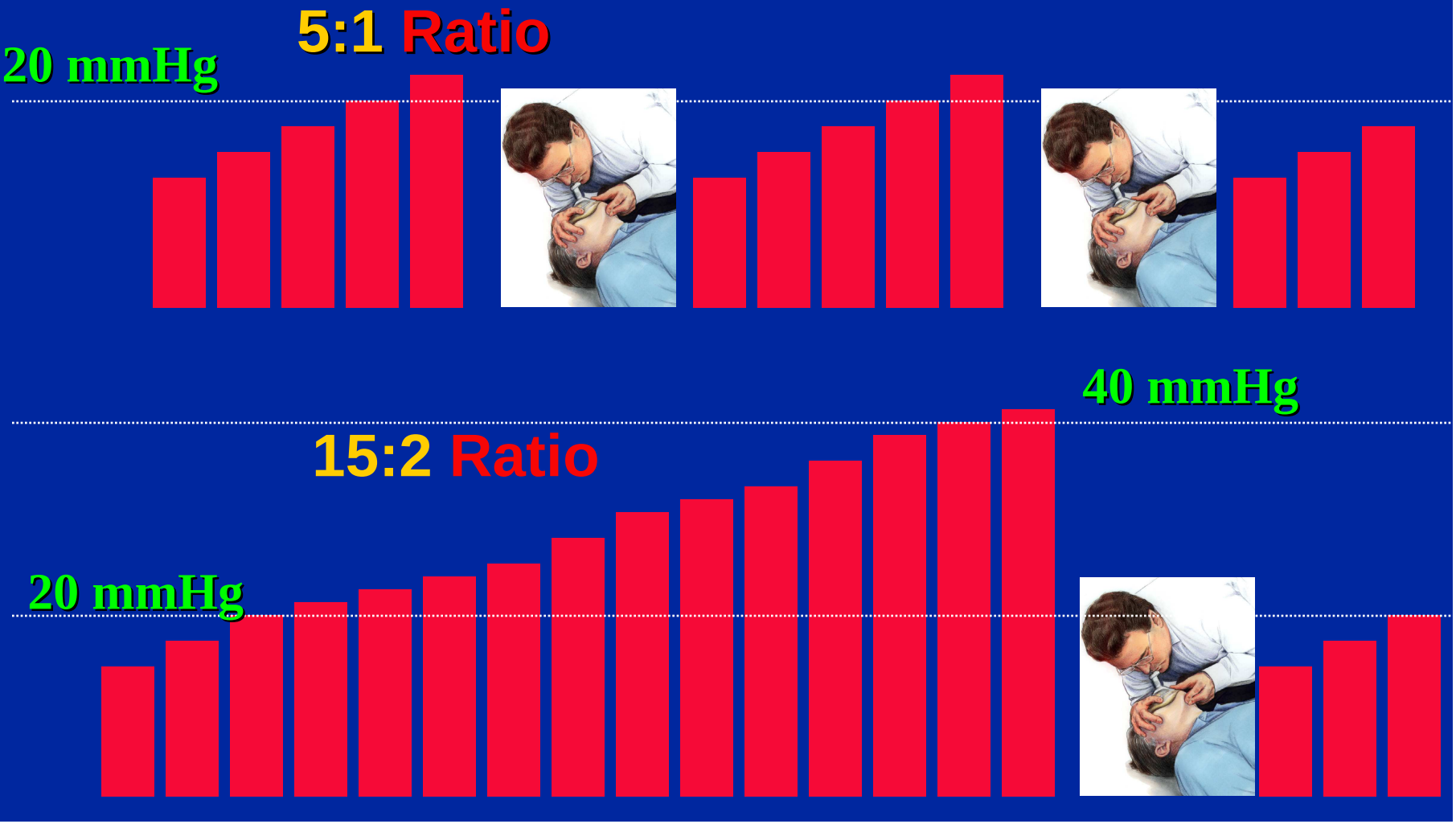
- Averaged 37 ± 4 breaths/min
- Re-trained at 12 / min
- Averaged 22 ± 3 breaths/min

Stopping to Breathe...

...Interrupts

Chest Compressions

Chest Compressions & *Coronary Perfusion Pressure*

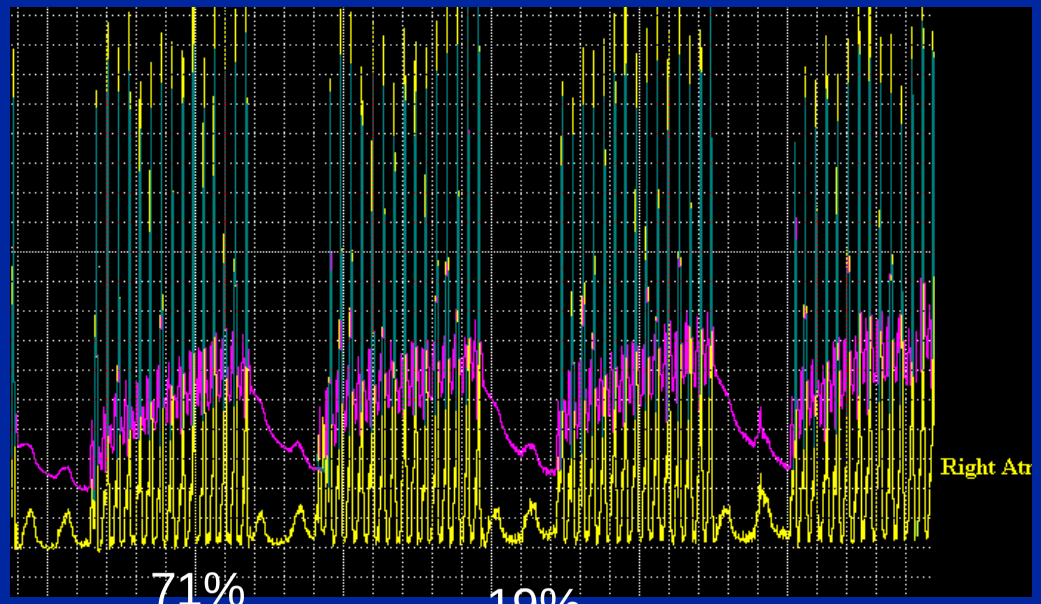


"A Reappraisal of Mouth-to-Mouth Ventilation During Bystander-Initiated CPR"

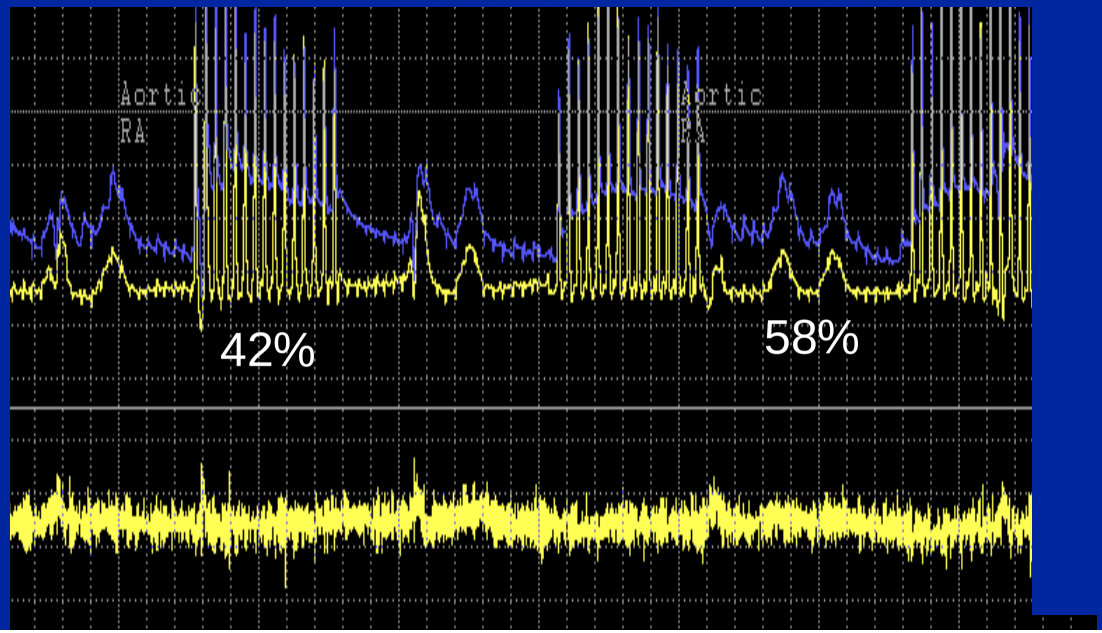
Becker, Berg, Pepe, et al

- *Circulation* — Sept 16, 1997
- *J Respiratory Care* — Sept. 1997
- *Ann Emerg Med* — Nov. 1997

Ideal CPR



Real CPR



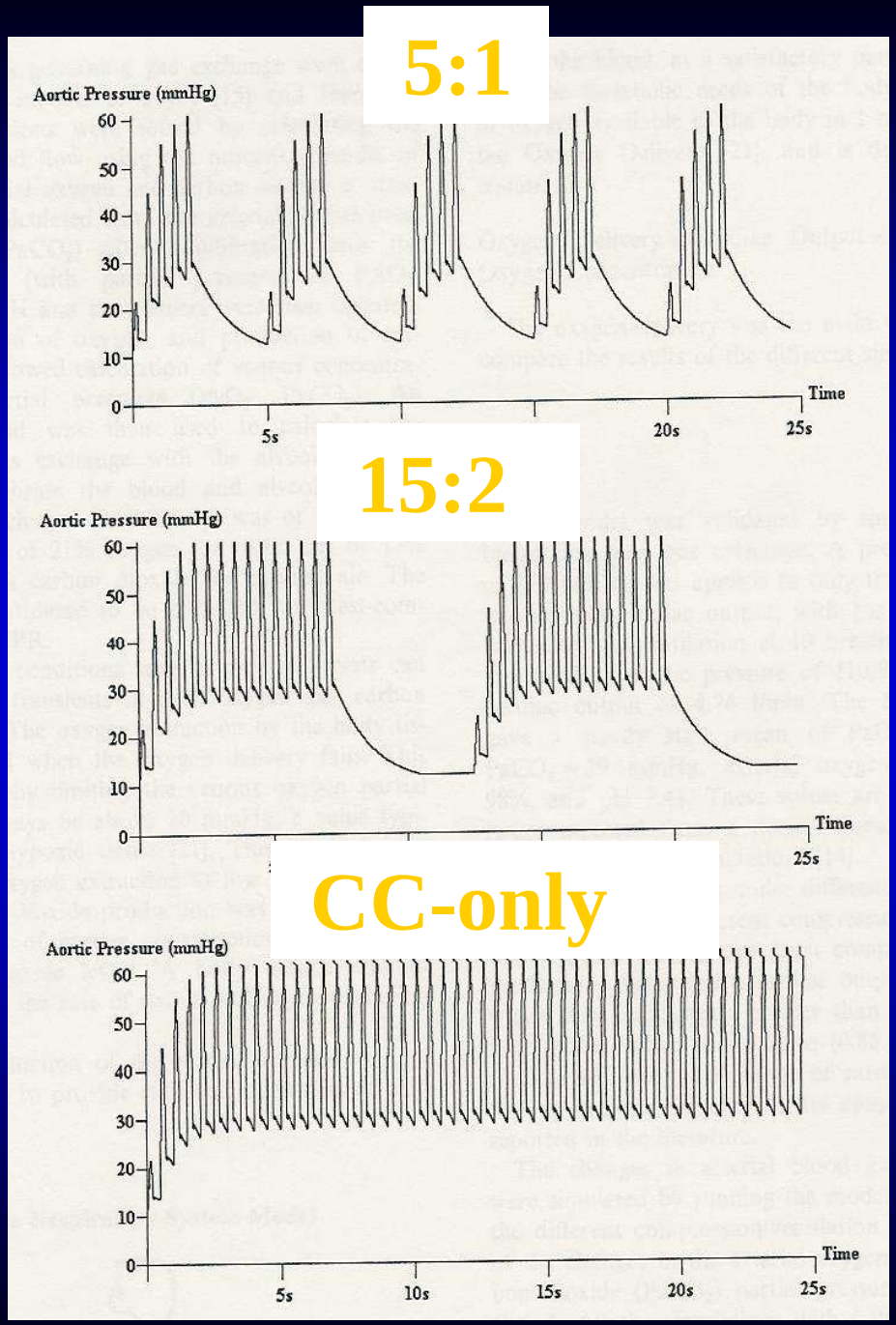
Interferes with Chest Compressions

- *1 person CPR* 80/min in only 15%
- *2 person CPR* 80/min in only 12%
- *129 Med Students* Averaged 56/min

Milander, et al *Acad Emerg Med* 1995;2:708

Wenzel, et al *Chest* 1994;106:1806

Wenzel, et al *Resuscitation* (in press)



Aortic Pressures

Using Different Compression To Ventilation Ratios

Turner et al, *Resuscitation*, 2002

Cardiac Arrest Survival Study

Breaths/Minute	Inhaled Gas	Survival Rate n= 7 in each group
12	100% O_2	86% 
30	100% O_2	14%* 
30 *P < 0.05	95% O_2 & 5% CO_2	14%* 

“Reality” CPR

In Video Study of Lay Individuals Recently Taught 15:2 CPR ….

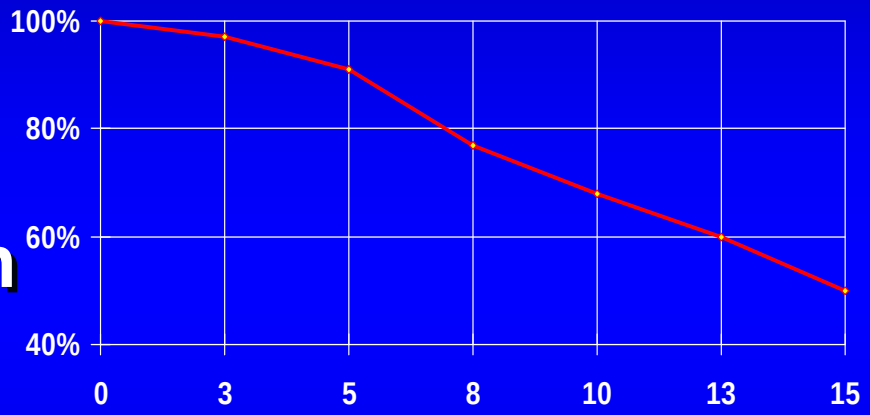
…Took 15-16 Seconds to Deliver the 2 Breaths

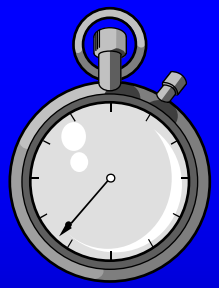
Is There Evidence That We Can Breathe Less Often?

Chest Compression without Ventilation

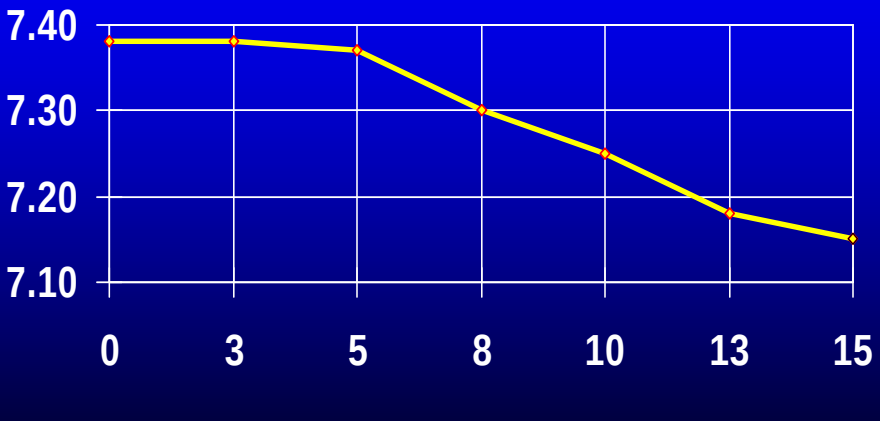
Chandra et al. Circulation 1994; 90:3070-5

Oxygen Saturation





Arterial pH



Gasping May Enhance:

- **Oxygenation** (more lung inflation)
- **Ventilation** (more efficient breath)
- **Circulation** (more venous return)

Latest Studies…

Listening for Gasps

Counted Breaths or …

…Listened for Breaths

RESULTS (n=1,007):

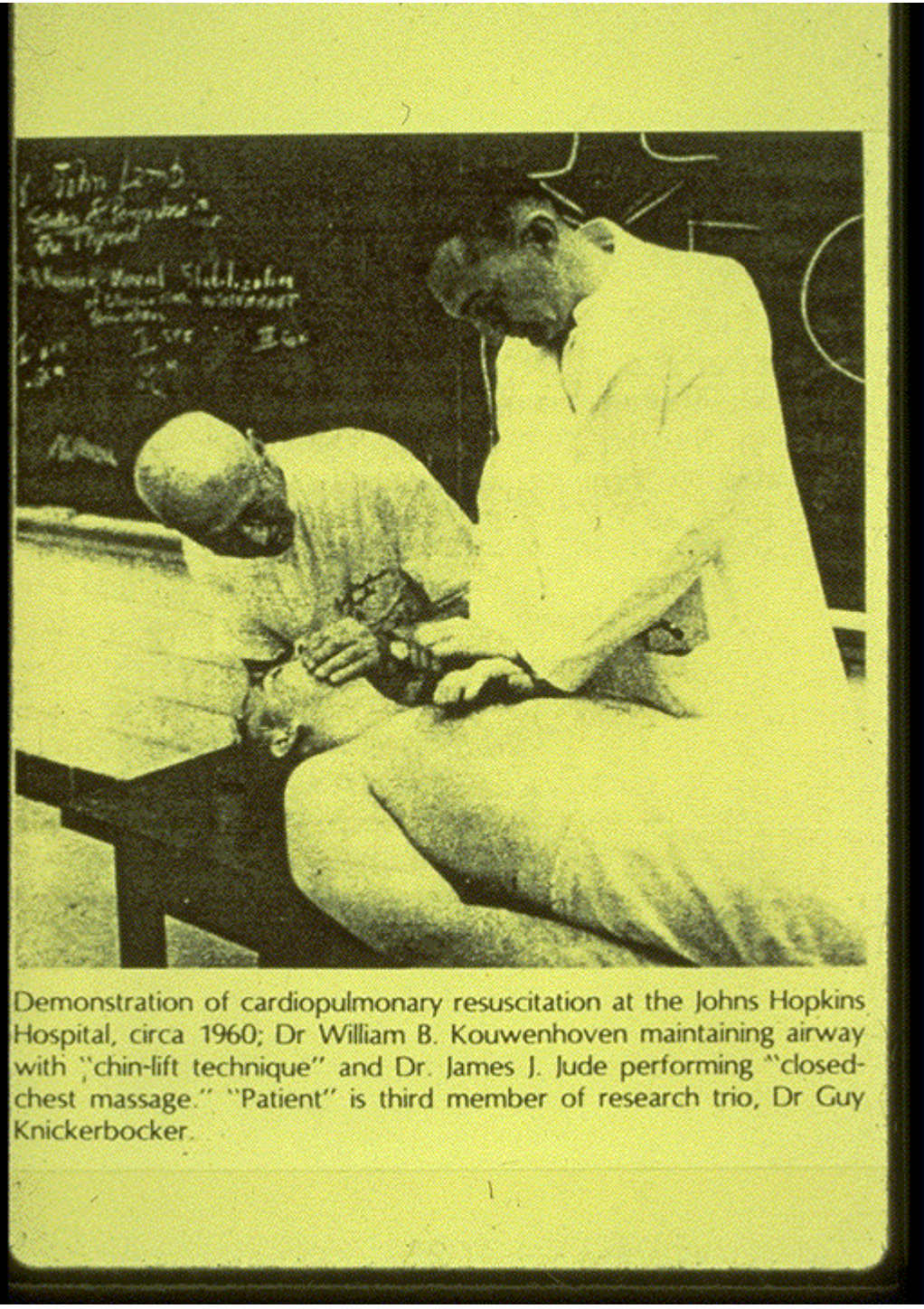
- # Cases Thought to Be Breathing Normally Fell from 29% to 20% (p<0.002)
- In the 8 Months Prior to Study… …No Patients Had Gasps Detected
- Versus 22 in the 4 Months After (p< 0.0001)
- Initital Rhythm Was VF or PEA in 85% of Those with Gasping

VF and VT MAY be Different Creatures than PEA and Asystole

- Different Energy States?
- Different Down Times?
- Different Causes?

How About Bystander CPR Training ?

So Why HAVE We Done What We've Done??



Demonstration of cardiopulmonary resuscitation at the Johns Hopkins Hospital, circa 1960; Dr William B. Kouwenhoven maintaining airway with "chin-lift technique" and Dr. James J. Jude performing "closed-chest massage." "Patient" is third member of research trio, Dr Guy Knickerbocker.

Dr. Peter Safar….

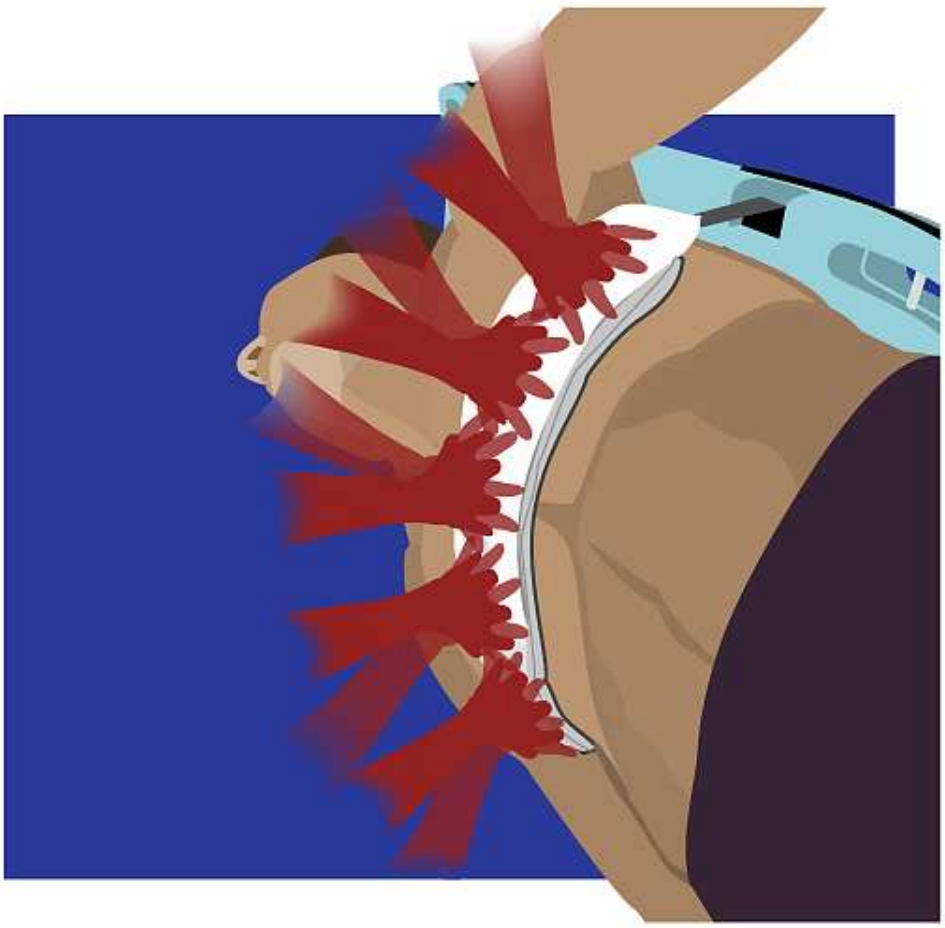
Original Studies...

Pulsing, Paralyzed Subjects

- Good O_2 Delivery
- No Gasping Ventilation

To Emphasize the CRITICAL Point…

Compressions Should Be Interrupted as Little as Possible



Active Compression--Decompression

Enhances Flow

-Asystole Saves
-Doubled VF Saves
-Awake During CPR

Digitized Evaluation: *CPR Depth, etc*

Only 4 Things Ya Need to Know…

- **Shock Immediately –**

  But if Ya Can't; Do Other Things 1st

- **Don't Interrupt CPR –**

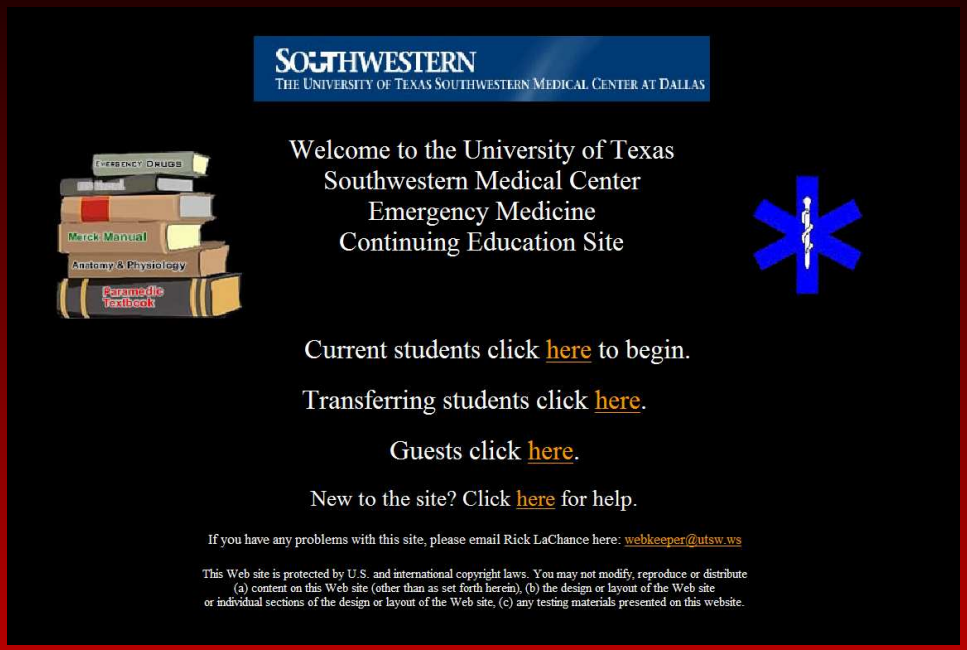
  Even if You Have To Breathe Less

- **Even if Intubated – Go Slow**

  Match Ventilation with Perfusion

- **Gasps Are Good – Go Slow**

  Keep 'Em Going with #'s 1 - 3



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Thank You!

? or !