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

Presented at EMS Today
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by Ray Fowler, MD, FACEP
for Dr. Paul Pepe
1 of Every 5 Persons Who Die in the U.S. ...

Will Die From Sudden Death Syndrome....
The Problem ...
Ventricular Fibrillation

... is not a static process
Electrical Deterioration of Ventricular Fibrillation
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Electrical Deterioration of Ventricular Fibrillation

= Depletion of Myocardial Energy Stores (ATP Depletion)
### Anticipated Post-Defibrillation Rhythms

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Rhythm Description</th>
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<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
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<tr>
<td>10</td>
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<td>15</td>
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V Fib Survival Rates

Without CPR

- 75% at 0 min
- 50% at 5 min
- 25% at 15 min

TIME (min)
THE REAL DUMMIES
NEVER BOTHER TO TAKE CPR.

Taking a Red Cross CPR class is one of the smartest things you'll ever do. Because by practicing life-saving CPR on dummies, you'll learn how to save real people's lives. Maybe the life of someone you love. Take CPR. Call the Red Cross.
Time to CPR and Cortical Blood Flow in Rabbits


CEREBRAL BLOOD FLOW % Pre-Arrest

Minutes to Precordial Compression

1 min

3 min

5 min
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)

% Resuscitated

A. Epinephrine, Airway, CPR and Then Shock
B. Airway, CPR & Shock
C. Shock Only
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)

%-Resuscitated

Shock First, Then Epi

High Dose Epi First
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

% Surviving

'78 '80 '82 '84 '86 '88 '90 '92
VF Survival Rates in Seattle

90 sec CPR Before Shock

'78 '80 '82 '84 '86 '88 '90 '92 '94 '96
VF Survival Rates in Seattle

Response <4 min

1990-1993
1994-1996

Response >4 min

0%
10%
20%
30%
40%
Lars Wik, et al...

Controlled Study:
3 min of CPR
Prior to Defib Attempts...

= Increased Survival!
VF Survival Rates in Oslo

- Shock 1st
- 3 min CPR

- p = 0.006
- p = 0.61

< 5 min vs > 5 min
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....

8 breaths / min

...Little CO₂ Excretion
Pulses Return

ETCO₂ mmHg

CPR
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% O₂), 30 breaths per minute (100% O₂), or 30 breaths per minute (5% CO₂/95% O₂). 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+ CO₂ 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 $37 \pm 4$ breaths/min
- Re-trained at 12 / min
- Averaged $22 \pm 3$ breaths/min
Stopping to Breathe...

...Interrupts

Chest Compressions
Chest Compressions & Coronary Perfusion Pressure

5:1 Ratio

20 mmHg

15:2 Ratio

20 mmHg

40 mmHg
“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
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**

Aortic Pressures Using Different Compression To Ventilation Ratios

5:1

15:2

CC-only

Turner et al, Resuscitation, 2002
# Cardiac Arrest Survival Study

<table>
<thead>
<tr>
<th>Breaths/Minute</th>
<th>Inhaled Gas</th>
<th>Survival Rate *P &lt; 0.05</th>
</tr>
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<tbody>
<tr>
<td>12</td>
<td>100% O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>86%</td>
</tr>
<tr>
<td>30</td>
<td>100% O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>14%*</td>
</tr>
<tr>
<td>30</td>
<td>95% O&lt;sub&gt;2&lt;/sub&gt; &amp; 5% CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>14%*</td>
</tr>
</tbody>
</table>

*n= 7 in each group*
“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


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 ...
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)

- Initial 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.
Original Studies...

*Pulsing, Paralyzed Subjects*

- Good O₂ 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*