Capnography and Ventilation for the EMS Professional

Advanced concepts in the ventilation of the acutely ill patient

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The Objective Question:

What is the relationship
between
exhaled carbon dioxide
and
cardiac output?

The Objective Question:

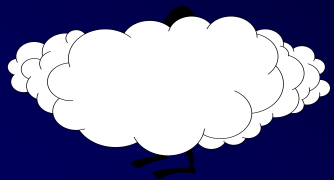
Directly proportional

or

Inversely proportional ??

What is Carbon Dioxide?

- **Capnos comes from the Greek word for "smoke"**

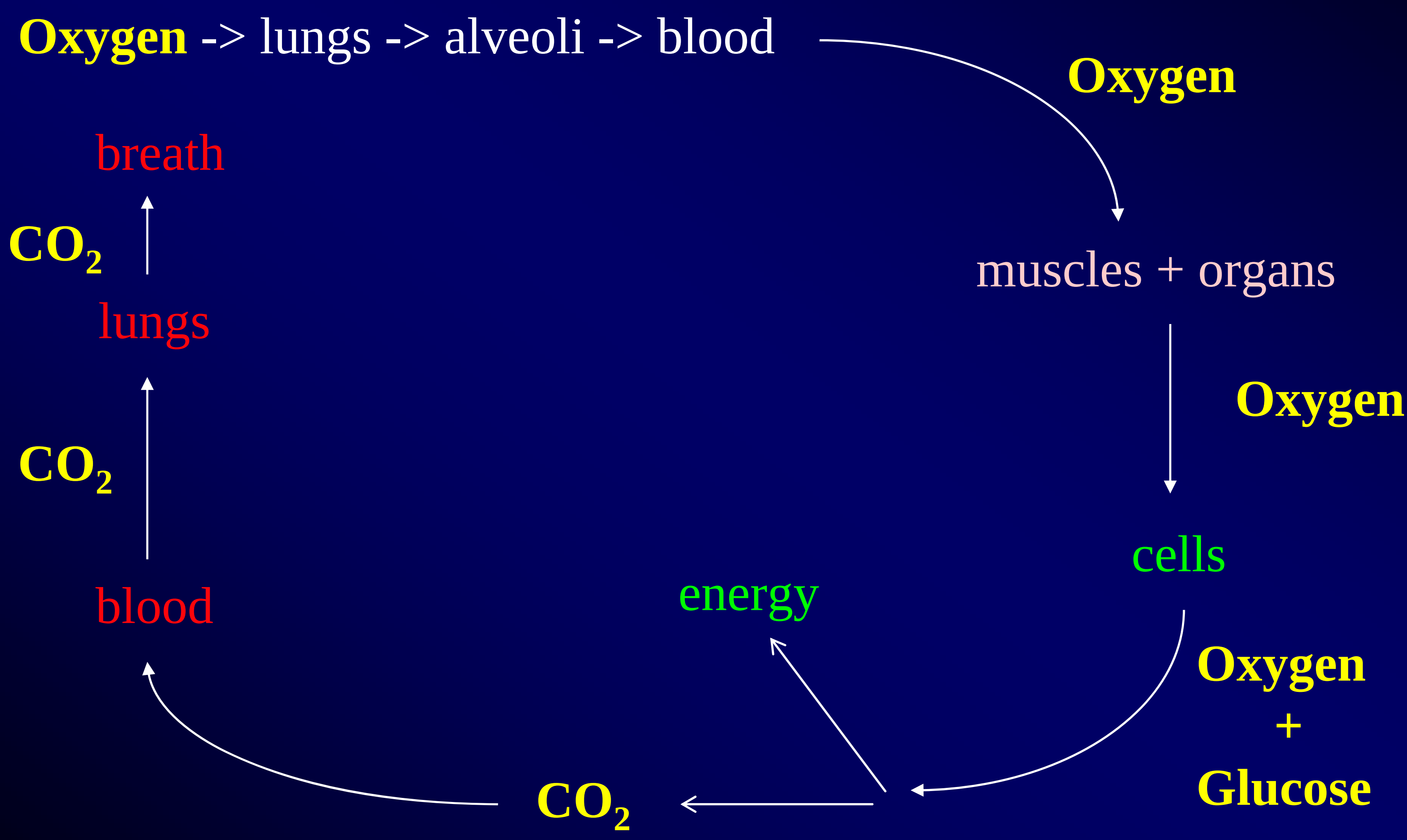


  - smoke from the fire of metabolism
  - a natural waste product of cellular activity
- **CO_2 is a compound molecule**
  - 2 elements of oxygen and 1 element of carbon
  - colorless and heavier than air
  - green plants clean up after our exhaled CO_2

Carbon dioxide physiology

$$CO_2 + H_2O \Leftrightarrow H_2CO_3 \Leftrightarrow H^+ + HCO_3^-$$

More specifically…



Carbon dioxide physiology

- 0.03% concentration in air
- Resting adult produces
  2.5 mg/kg/min
- In a 70 kg adult, that is about
  175 mg per minute, or about
  4% of a teaspoonful

Carbon dioxide physiology

- **Transported in blood**
  - 60-70% bicarbonate ion after conversion in RBCs using carbonic anhydrase
  - 20-30% bound to proteins (e.g., Hb)
  - 5-10% in physical solution (PCO_2)
- **Cleared by alveolar ventilation**

Alveoli: The Place Where Gas Exchange Happens

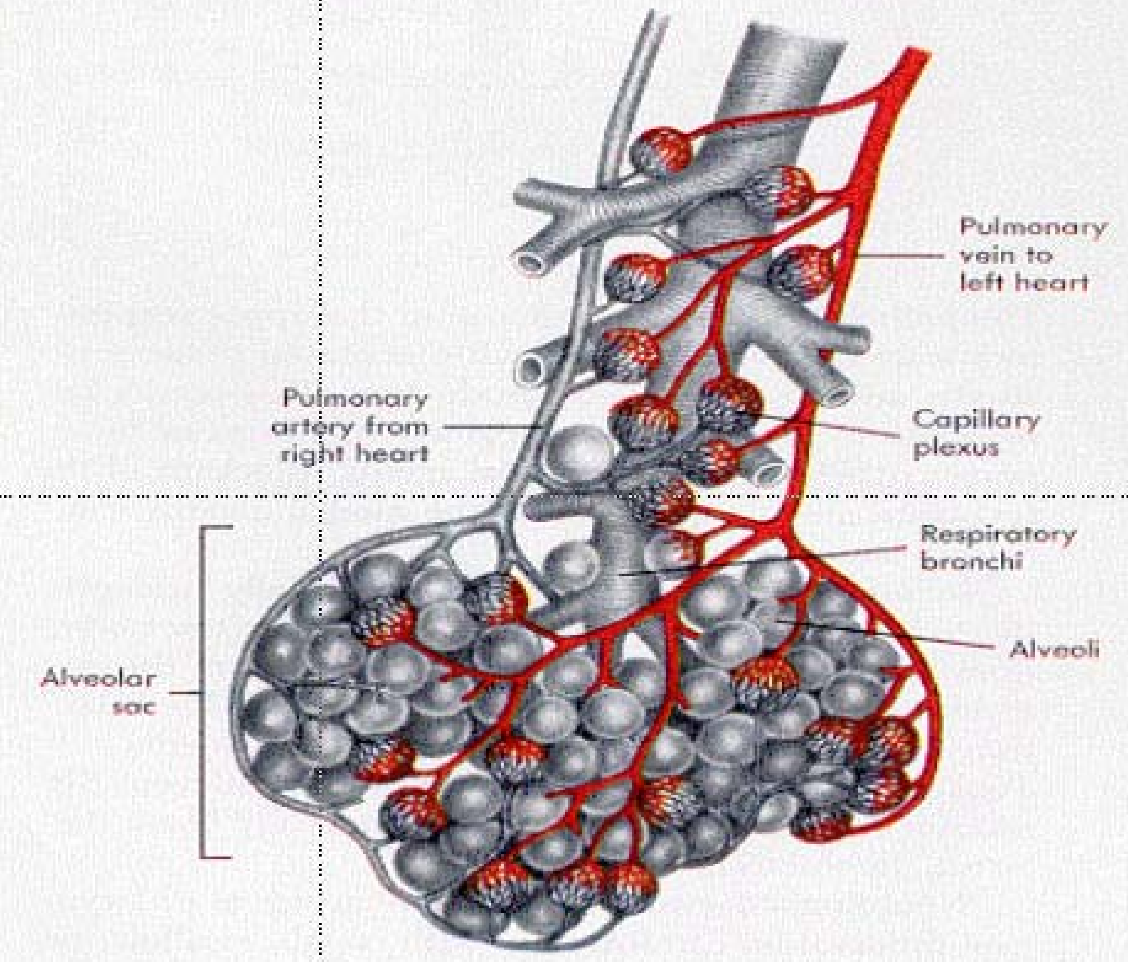
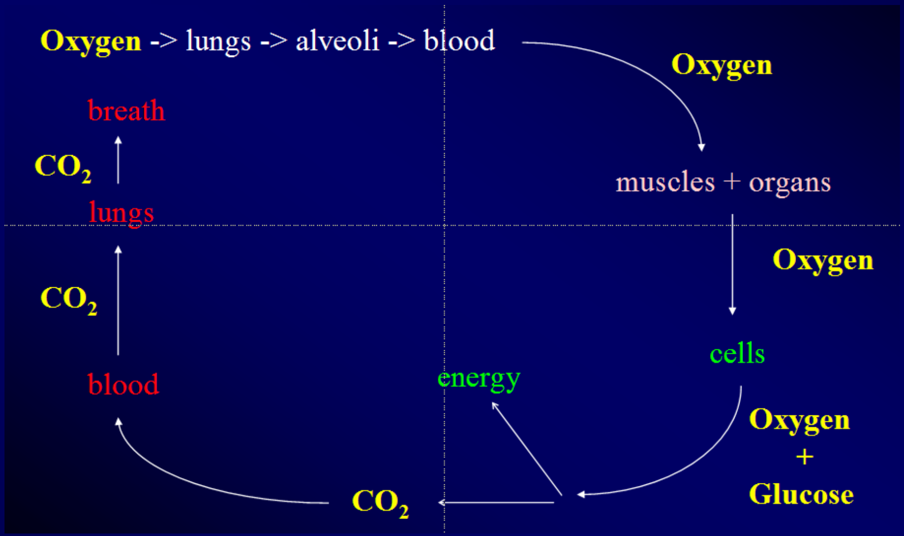


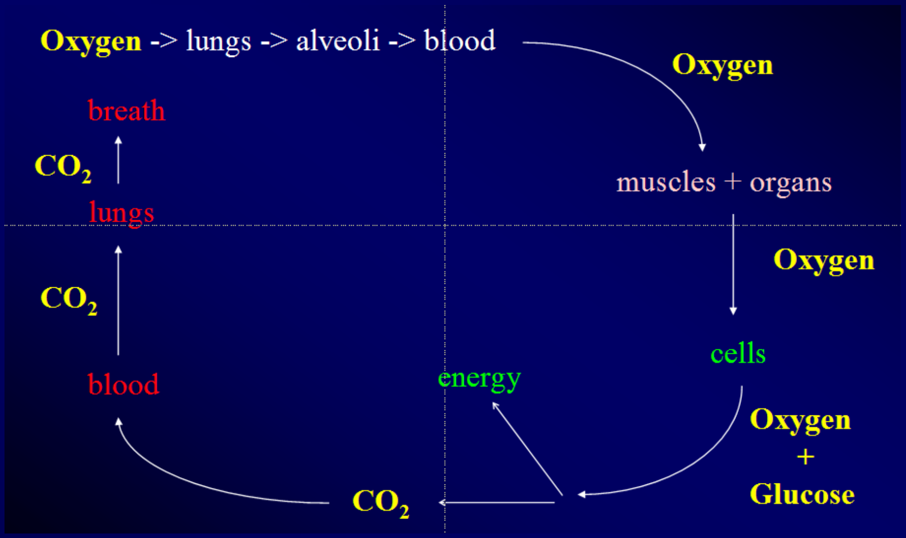
FIGURE 1-9
Structure of an acinus.



Oxygen Consumption

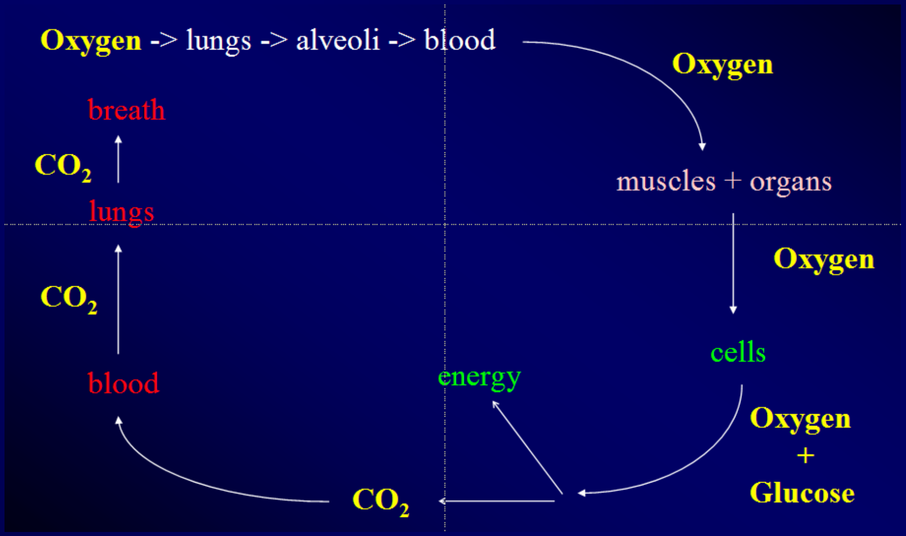
Largely Dependent on Oxygen Delivery...

...in low flow states



Oxygenation

- Adequate Lung Inflation
- Supplemental O_2



CO_2 Production

Largely Dependent on Oxygen Consumption

Need to Ventilate

- **CO_2 Production**

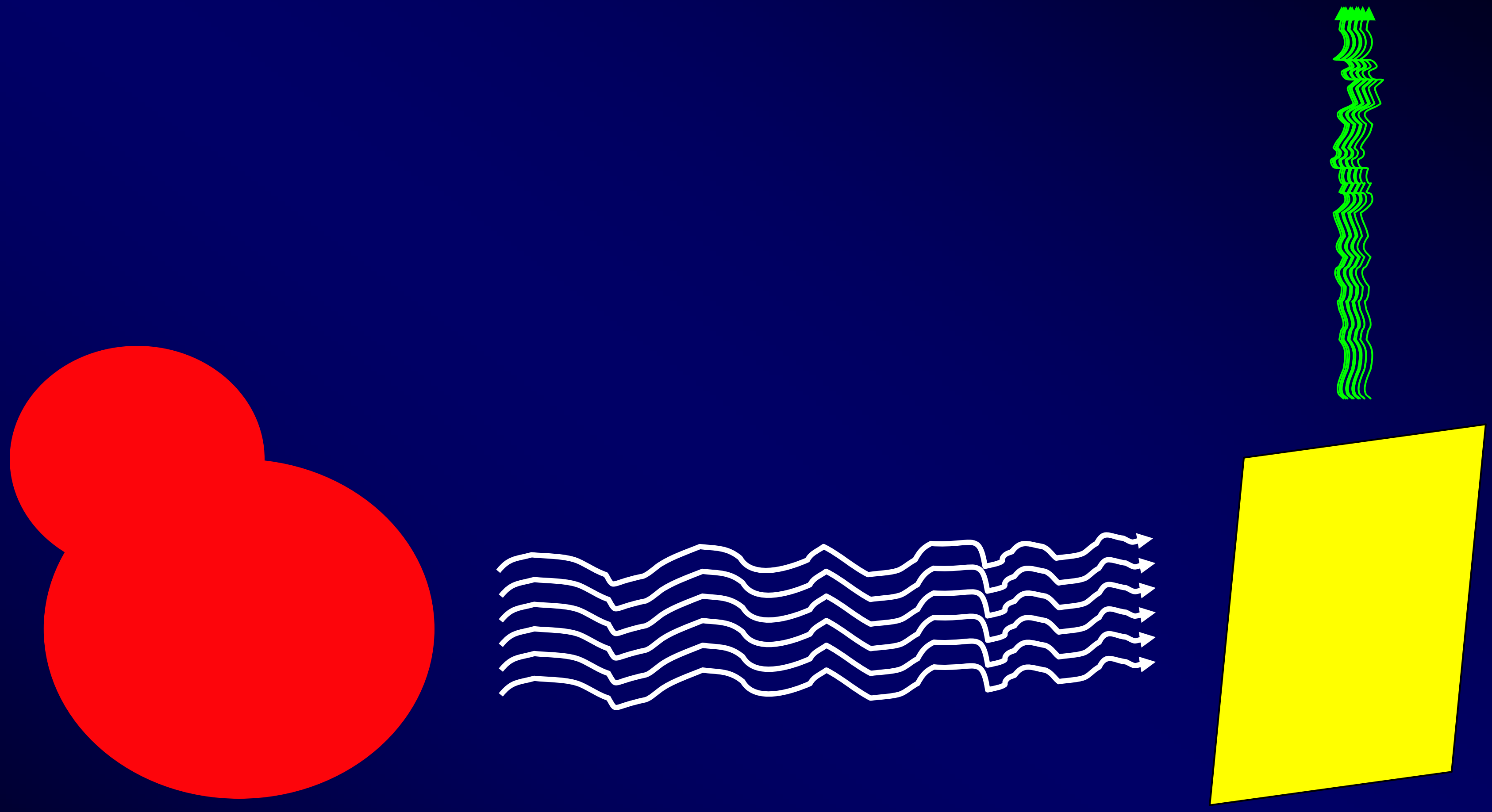
  (O_2 Consumption & Venous Return)

- **Dead Space**

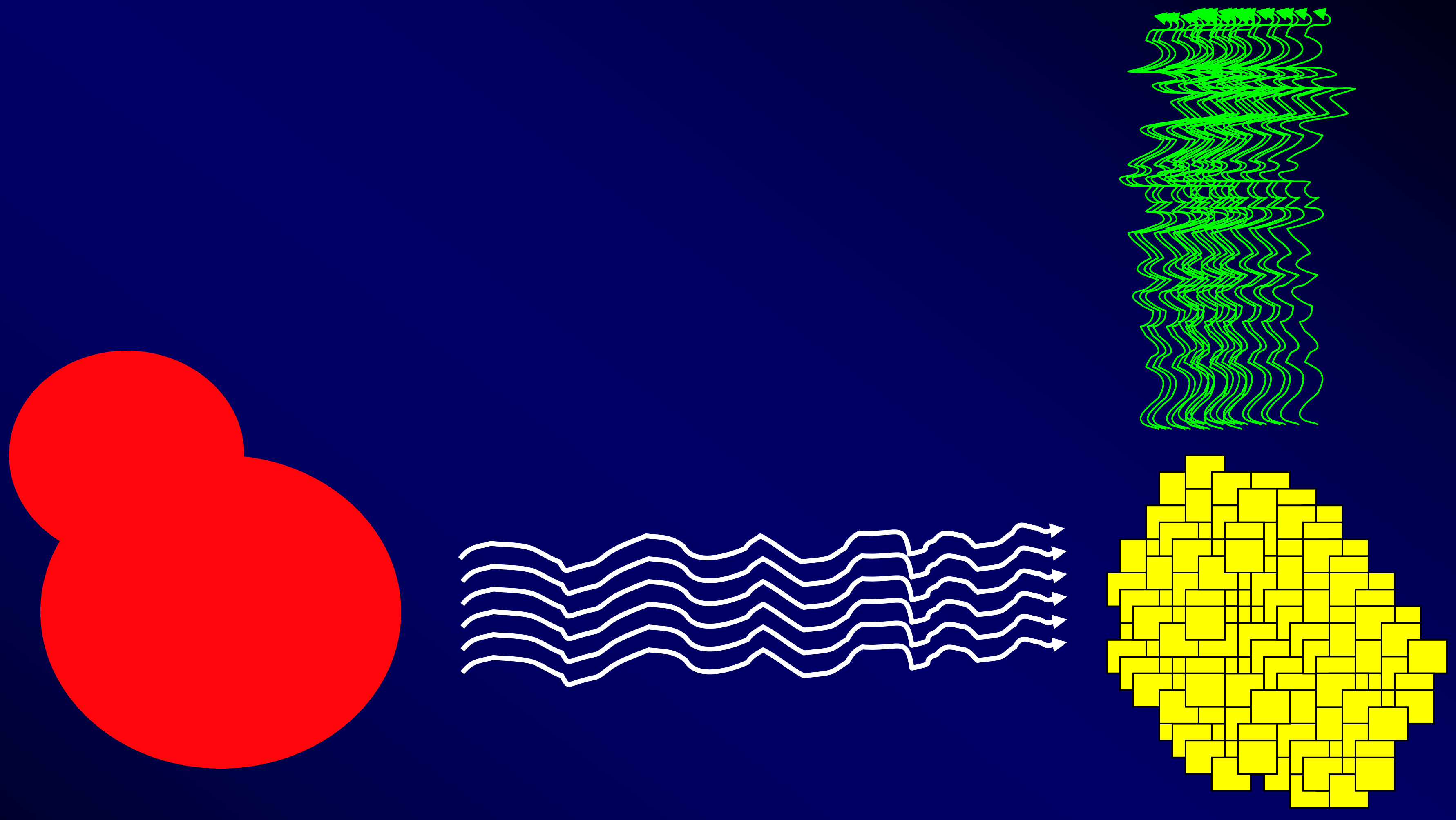
  (wasted ventilation)

Thus!!!
The “Speed” of Ventilation

- CO_2 Production
- Increased Dead Space



11/11/2006



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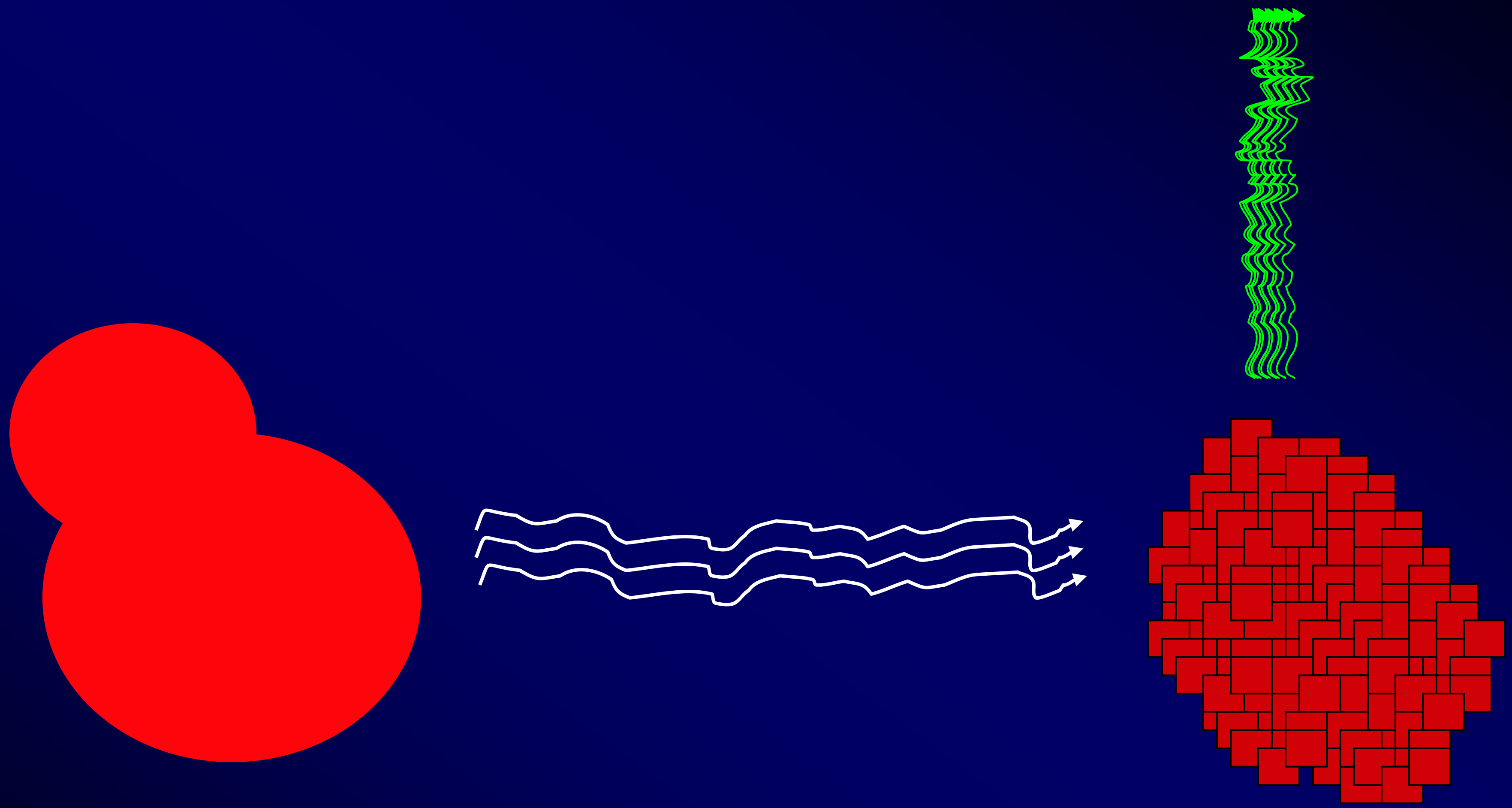
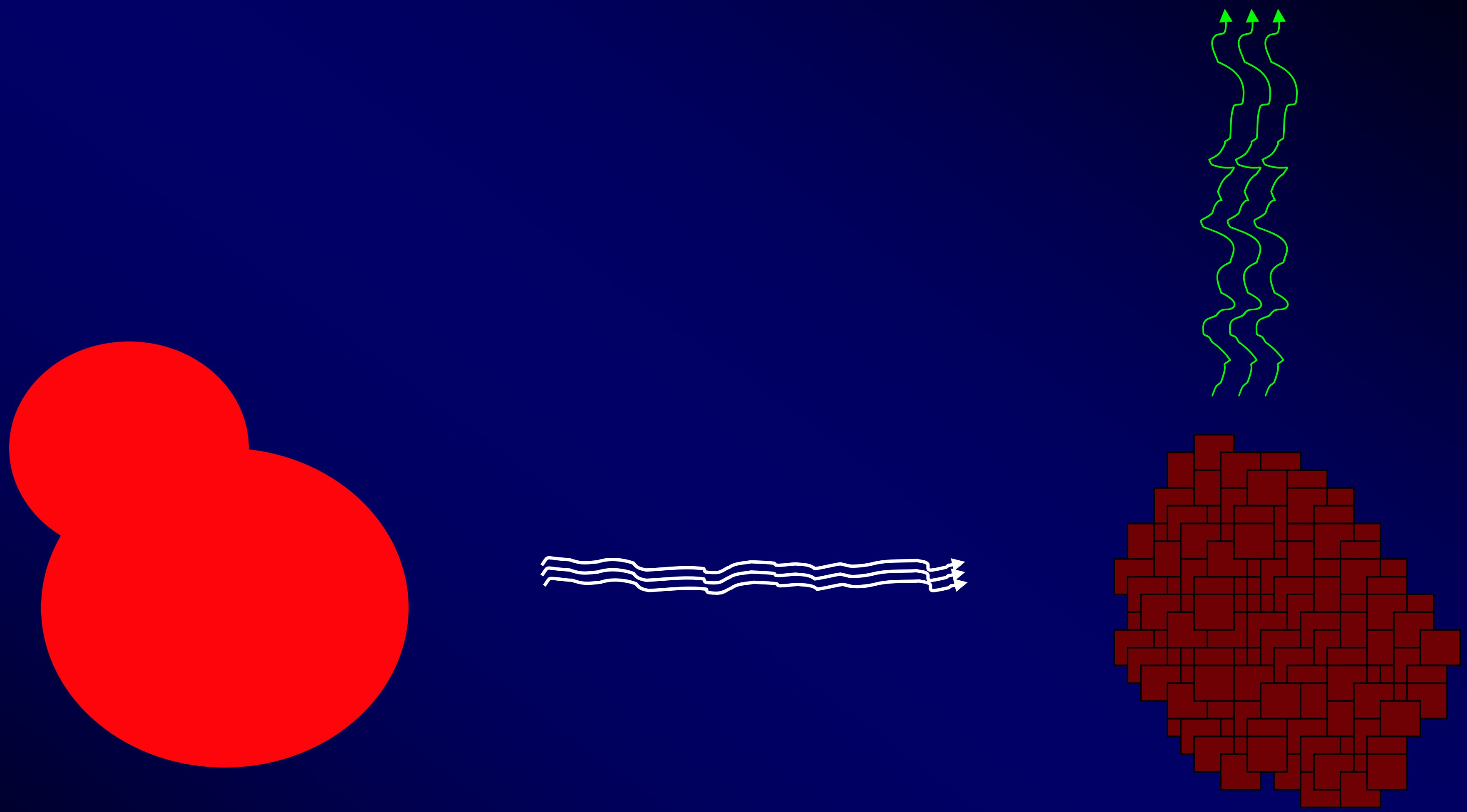


11/11/2006



11/11/2006

Blood pressure =

(Cardiac output) x
(Volume) x
(Peripheral resistance)

Shock

Cardiogenic

Rapid pulse
Distended neck veins
Cyanosis

Volume Loss

Rapid pulse
Flat neck veins
Pale

Vasodilatory

Variable pulse
Flat neck veins
Pale or pink

Signs of Shock

Early →

- Weak, thirsty, lightheaded
- Pale, then sweaty
- Tachycardia
- Tachypnea
- Diminished urinary output

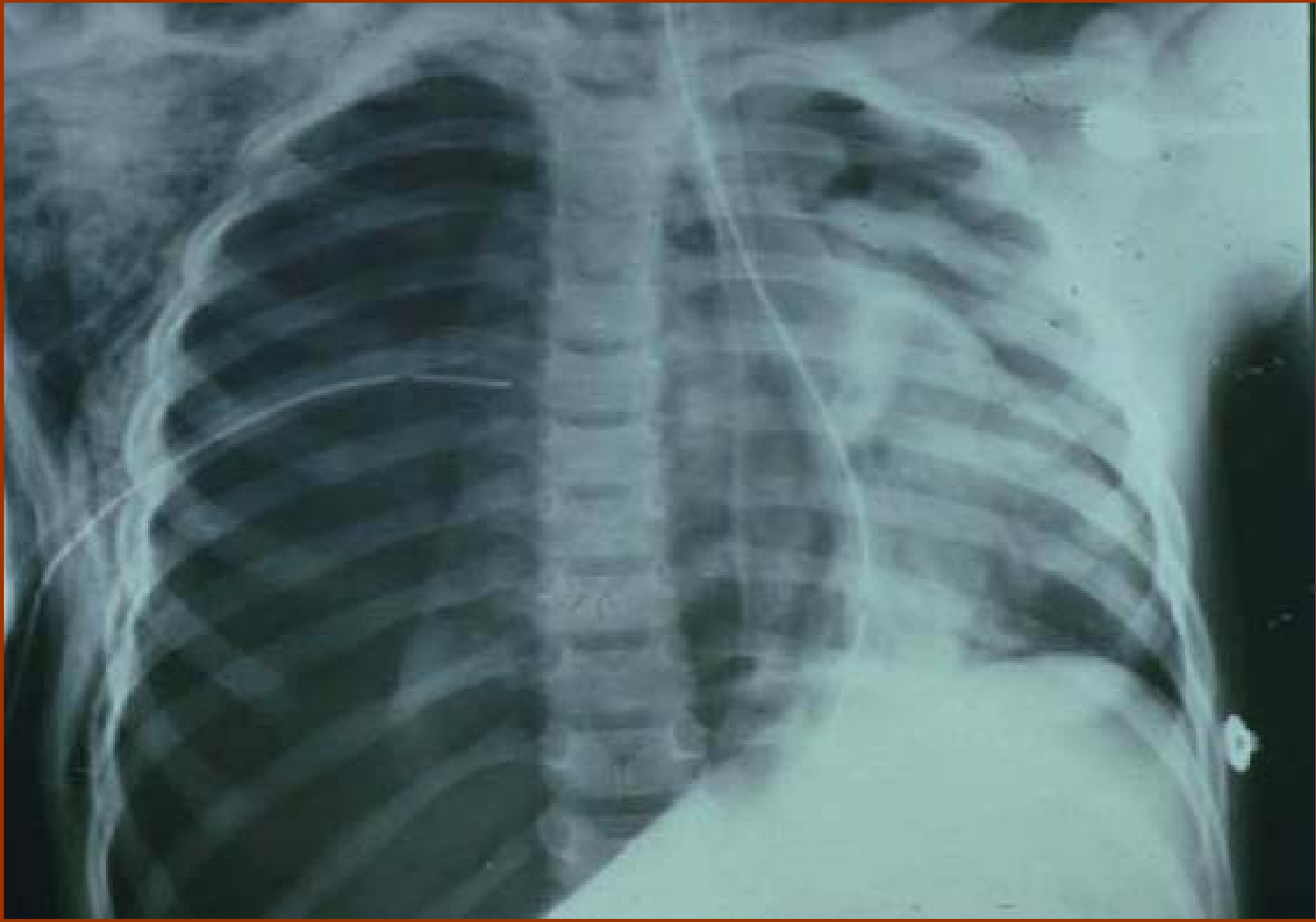
Late →

- Hypotension
- Altered LOC
- Cardiac arrest
- Death

As circulation fails,
the ability of the heart
to “blow on the coals”
that are the cells
of the body
is reduced

Examples:

- Shock of any cause
- Tension pneumo
- Massive hemorrhage
- Cardiac arrest
- Sepsis



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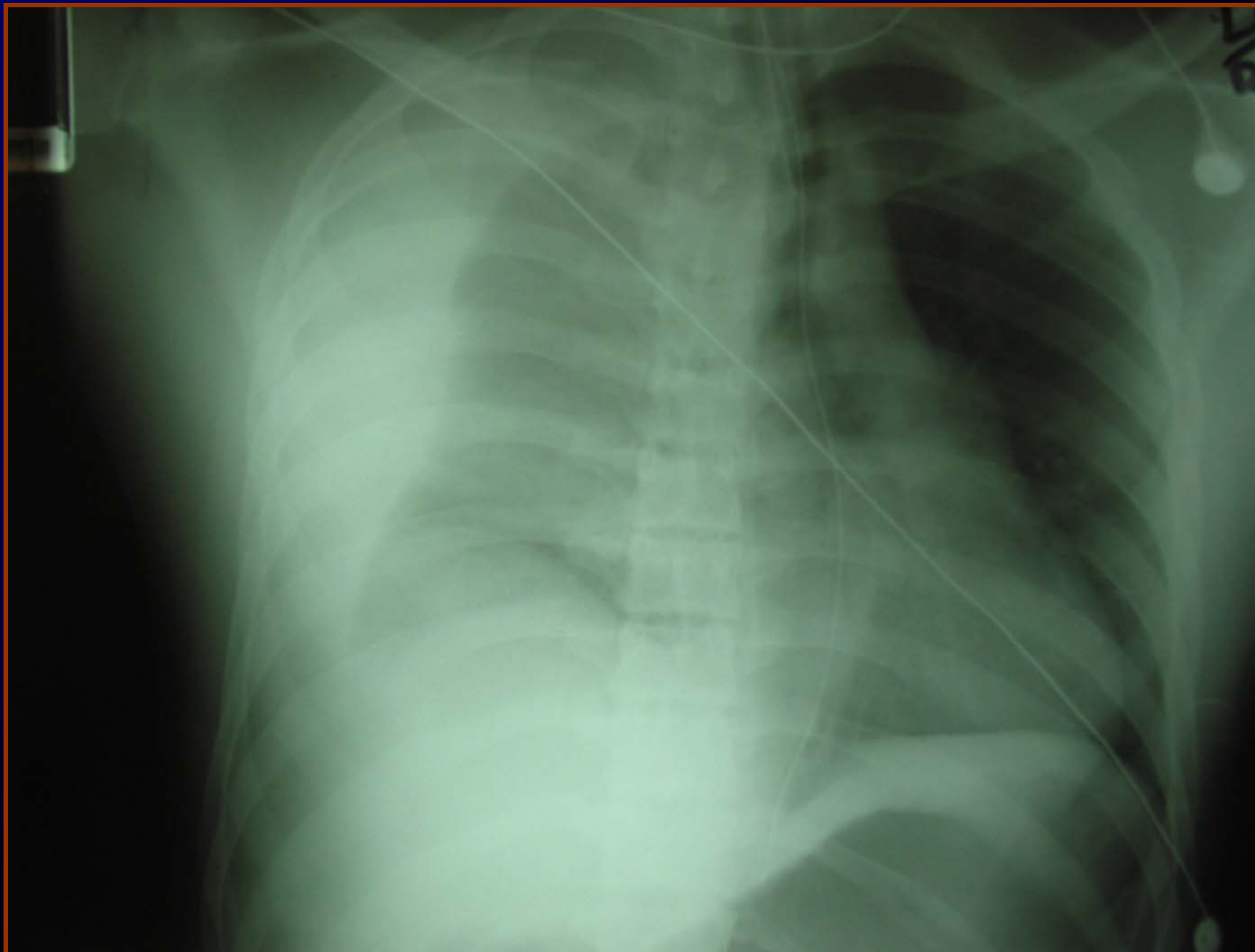


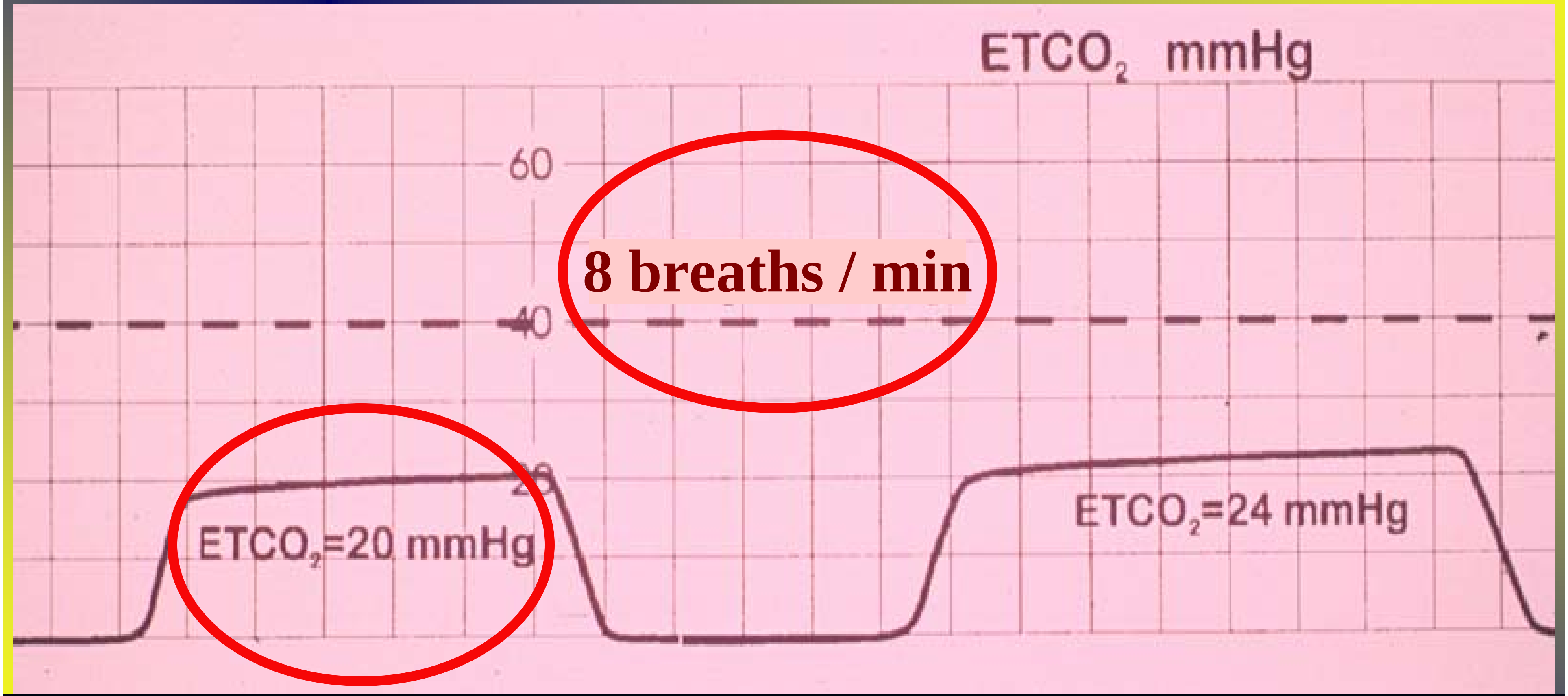
Consider Cardiac Arrest

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

...Little Need to Ventilate!!

FIG. 105. ARTIFICIAL RESPIRATION.
Raising and lowering arms. Third Method.

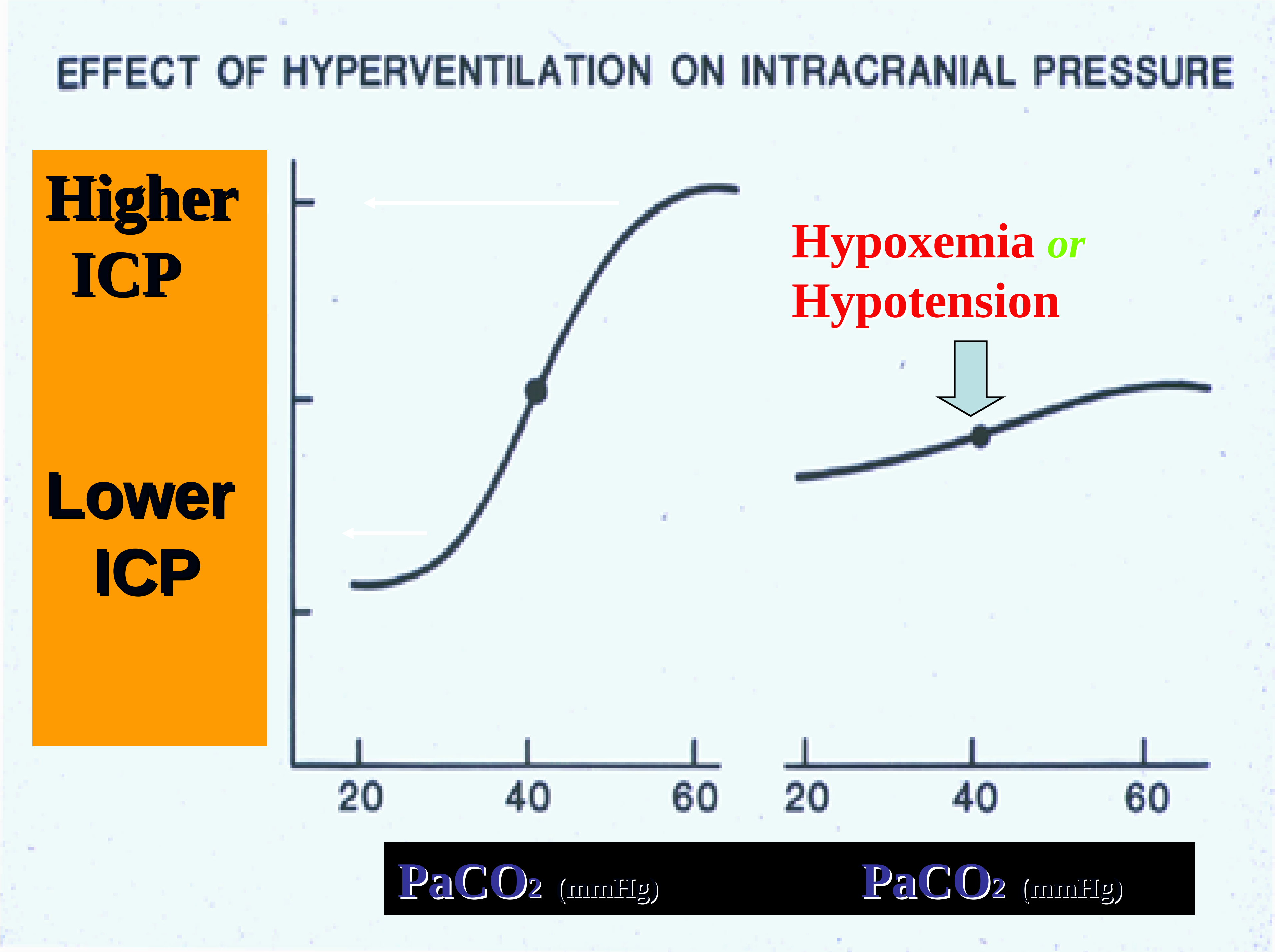
Cardiac Arrest….

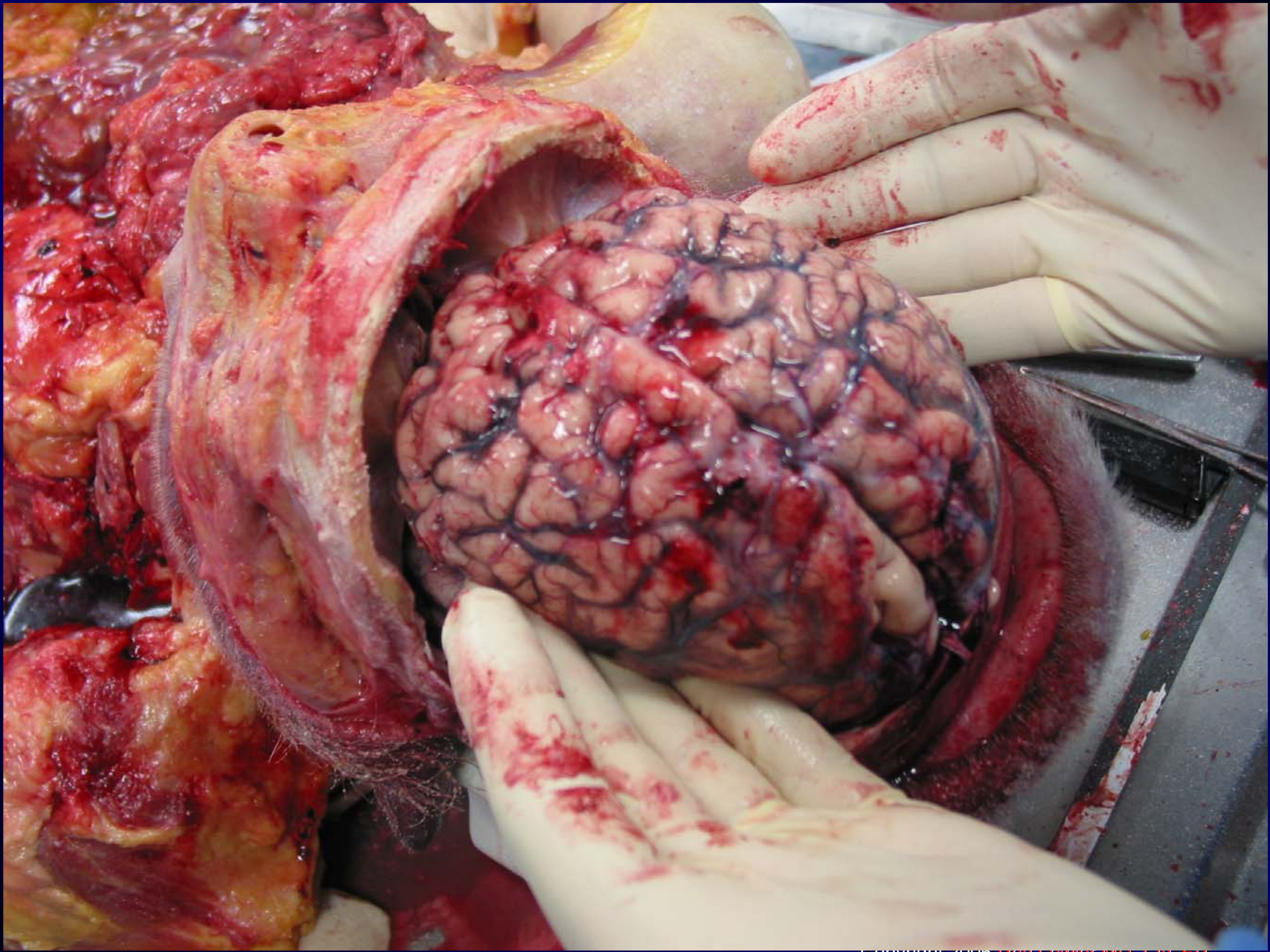


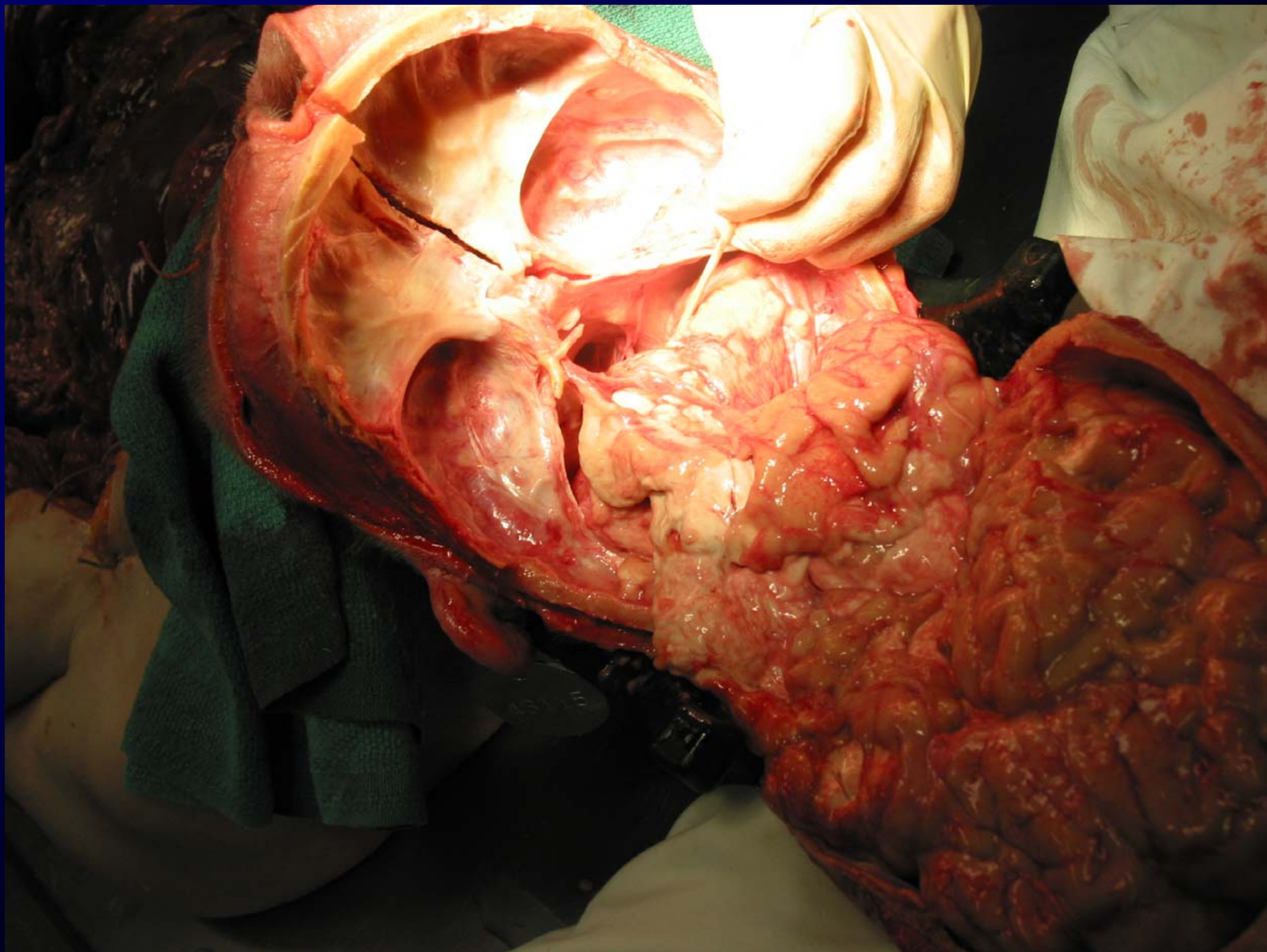
…Little CO_2 Excretion

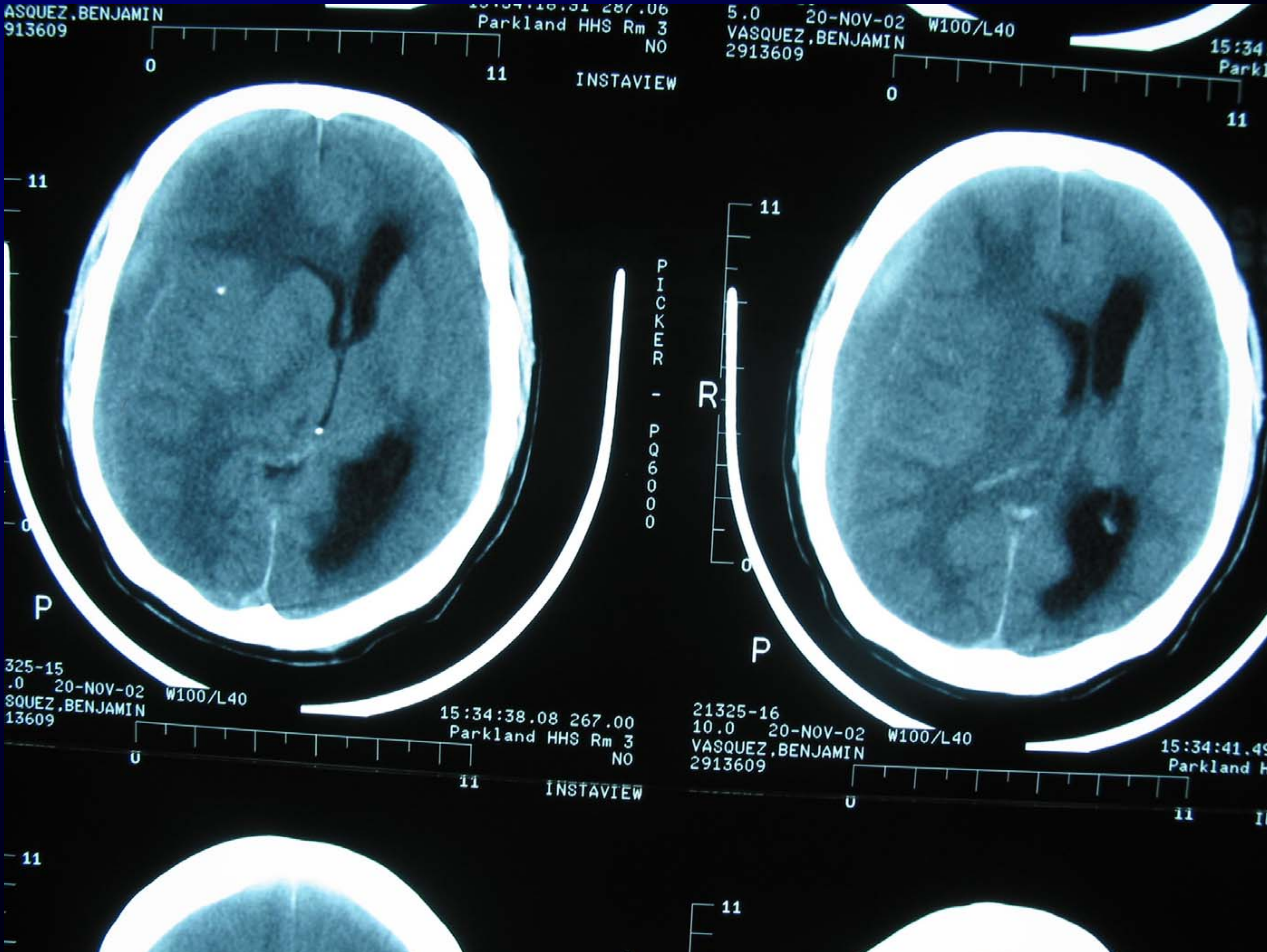
Where did this hyperventilation thing come from anyway?

- All of the head trauma discussion dating back to the 80’s and before
- Grief and relief after dealing with a difficult airway


EFFECT OF HYPERVENTILATION ON INTRACRANIAL PRESSURE
Higher ICP
Lower ICP
Hypoxemia or Hypotension
20
40
60
20
40
60
PaCO2 (mmHg)
PaCO2 (mmHg)



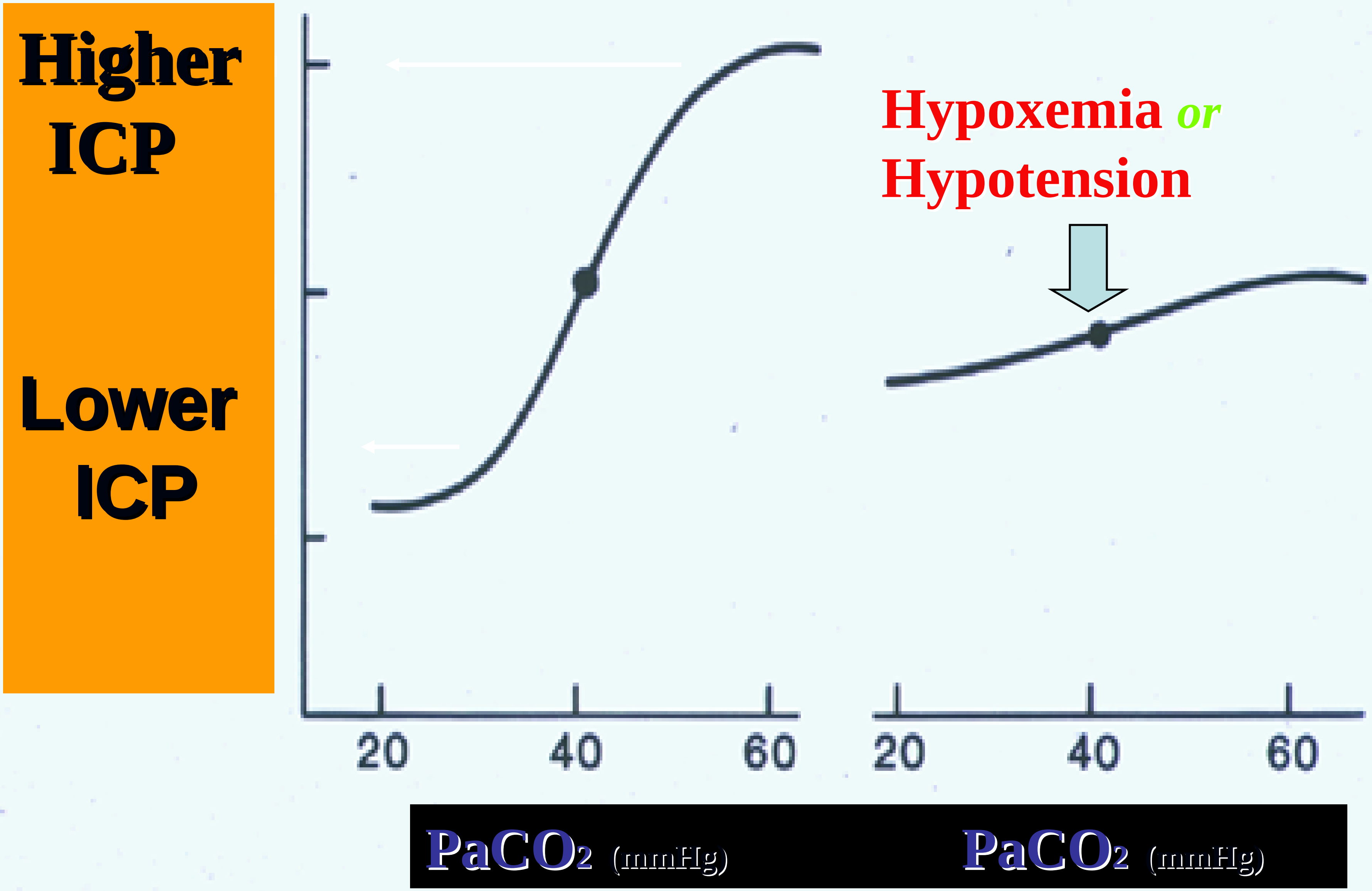




ASQUEZ,BENJAMIN
913609
Parkland HHS Rm 3
NO
INSTAVIEW
5.0 20-NOV-02 W100/L40
VASQUEZ,BENJAMIN
2913609
PICKER - PQ6000
R
P
325-15
20-NOV-02 W100/L40
SQUEZ,BENJAMIN
13609
15:34:38.08 267.00
Parkland HHS Rm 3
NO
INSTAVIEW
21325-16
10.0 20-NOV-02 W100/L40
VASQUEZ,BENJAMIN
2913609
15:34:41.49

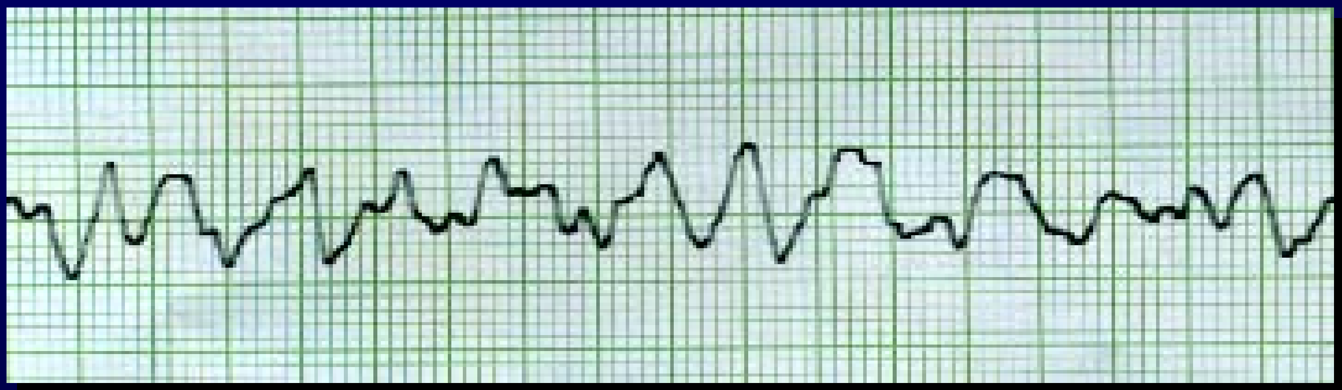
The Response of
Intracranial Pressure
to changes in
carbon dioxide is
less when the patient is
in circulatory compromise

EFFECT OF HYPERVENTILATION ON INTRACRANIAL PRESSURE



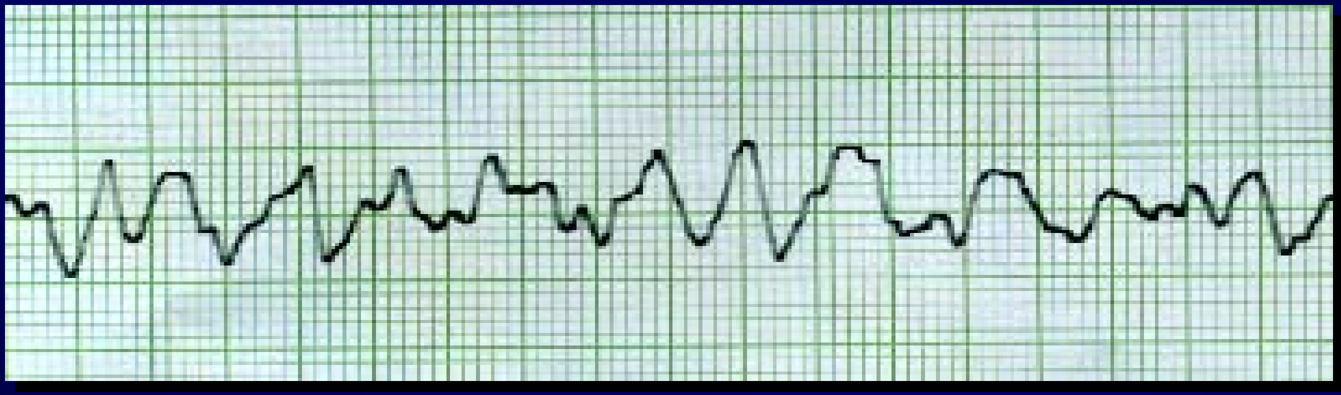
Let's think about a Cardiac Arrest case…

A 55 year old man
is found down in Cardiac Arrest
by his wife. EMS is called.
Citizen CPR is being done



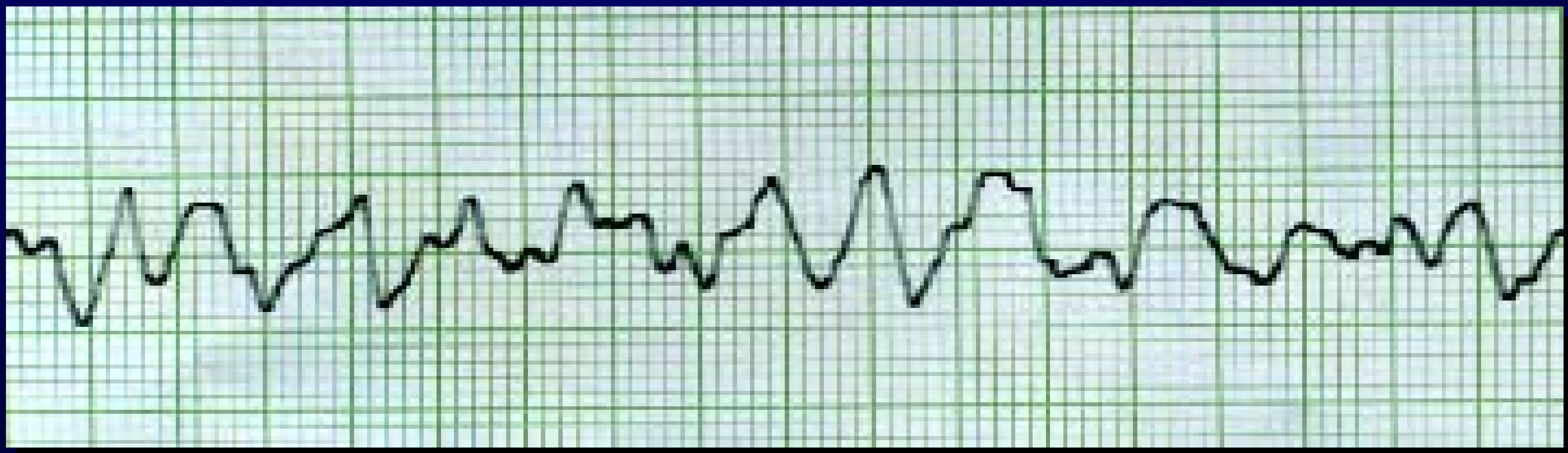
He was well until this happened.
He has no medical problems
and takes no medications.

After defibrillation the patient remains in this rhythm



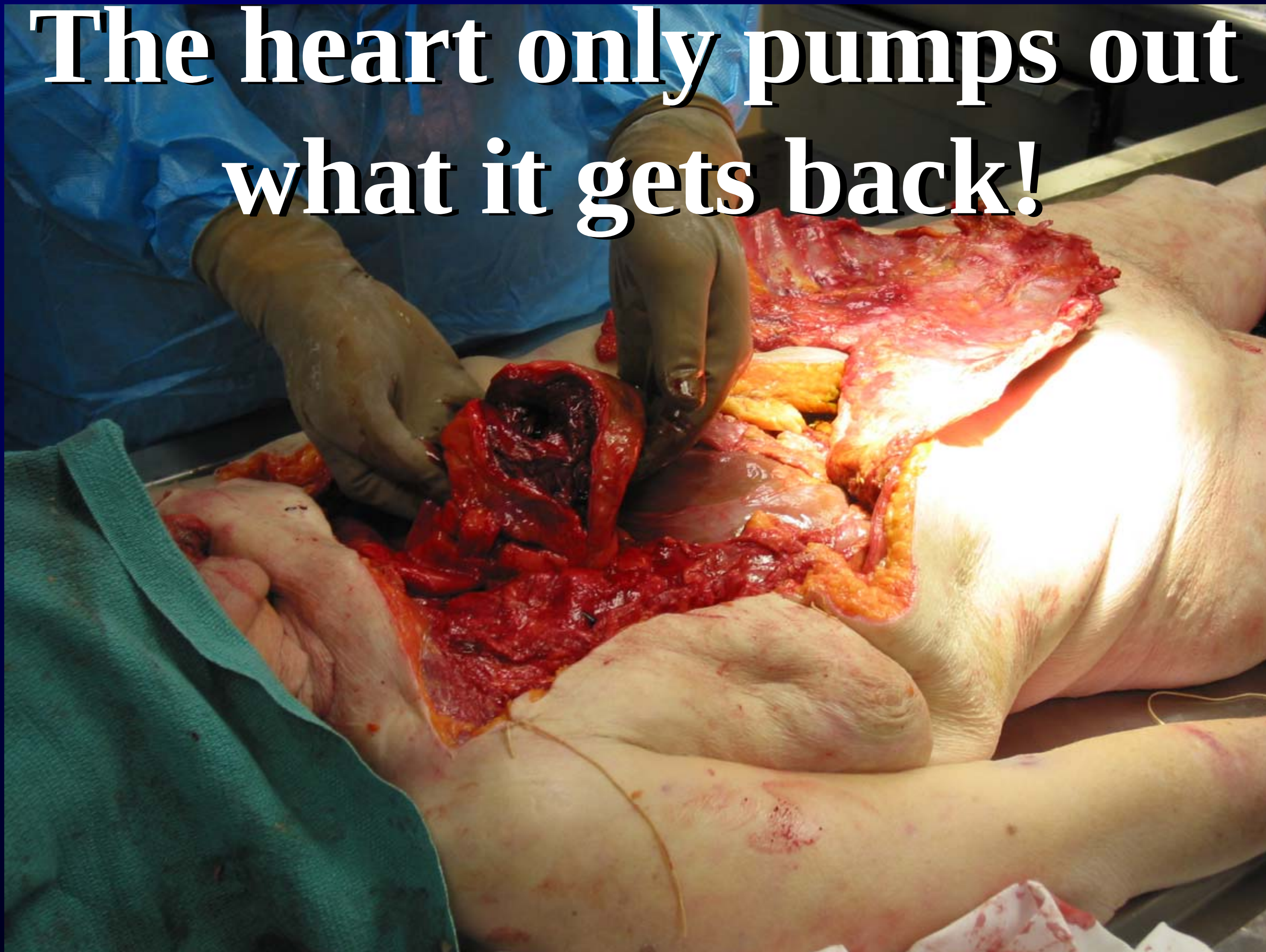
He does not improve after CPR and the administration of epinephrine or amiodarone

What do you do??



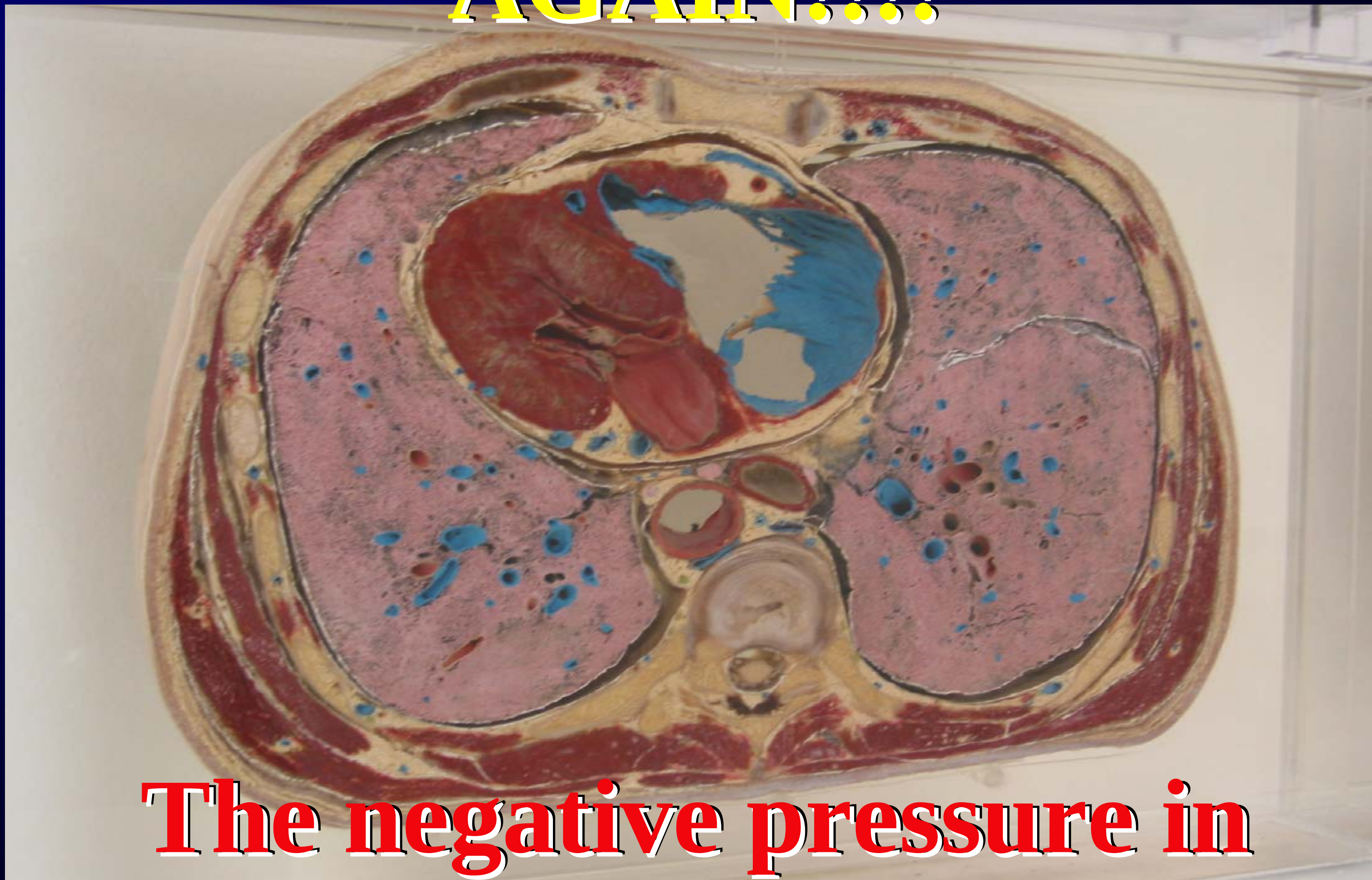
REMEMBER:

The heart only pumps out what it gets back!



The negative pressure in the thorax PULLS blood back!

AGAIN!!!!



The negative pressure in the thorax PULLS blood back!

Blood pressure =

(Cardiac output) x
(Volume) x
(Peripheral resistance)

Cardiac Output =

Pulse Rate

x

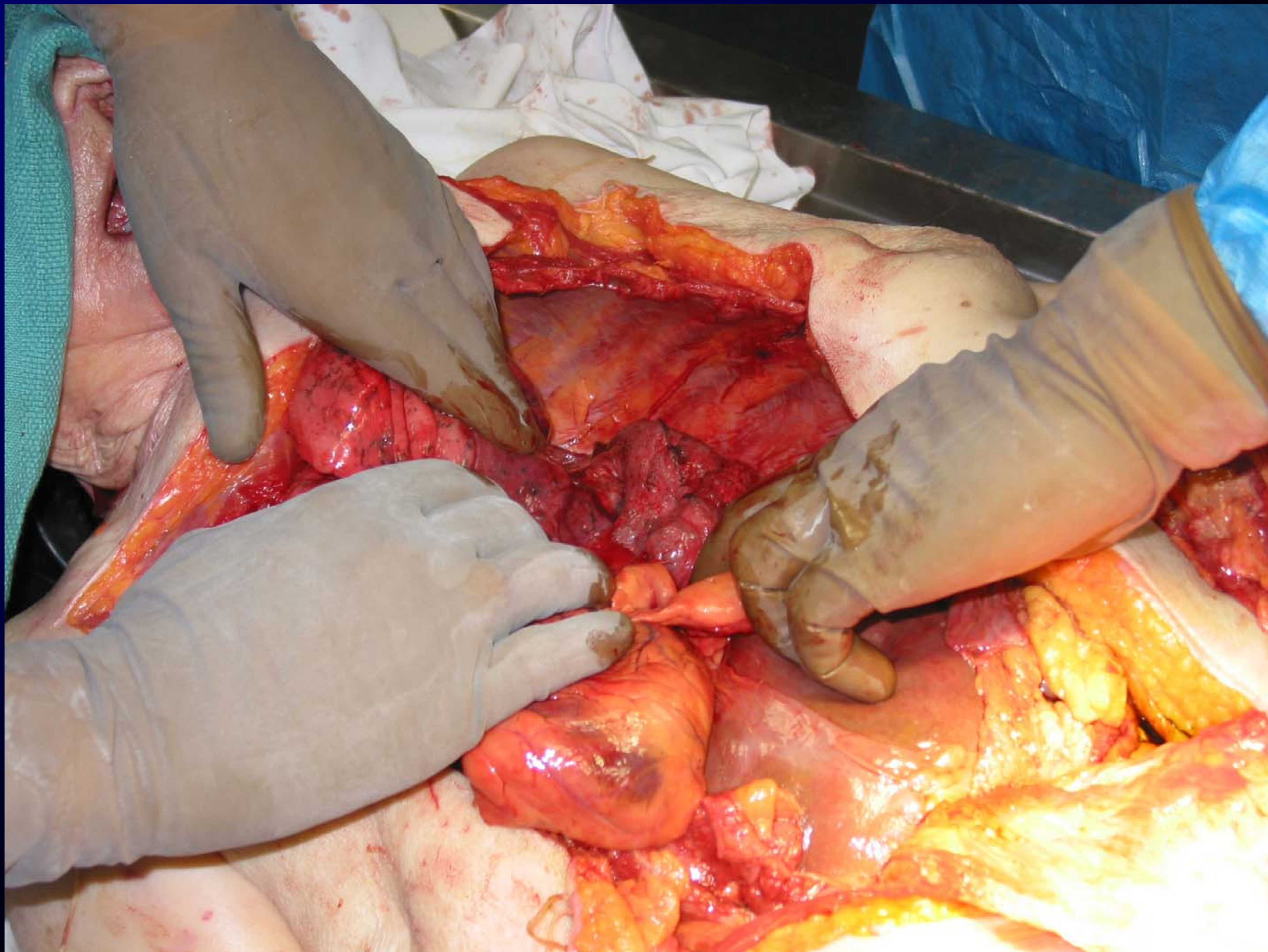
Stroke Volume

Understanding the body by regions

Positive pressure

Negative pressure

Positive pressure



The negative pressure inside the thorax “pulls” blood back from the positive pressure areas.

Positive pressure

Negative pressure

Positive pressure

Maintaining the "negativity" of the pressure inside of the thorax is one of the most vital areas of understanding resuscitation

Negative pressure

Positive Pressure in the Thorax decreases Venous Return!!

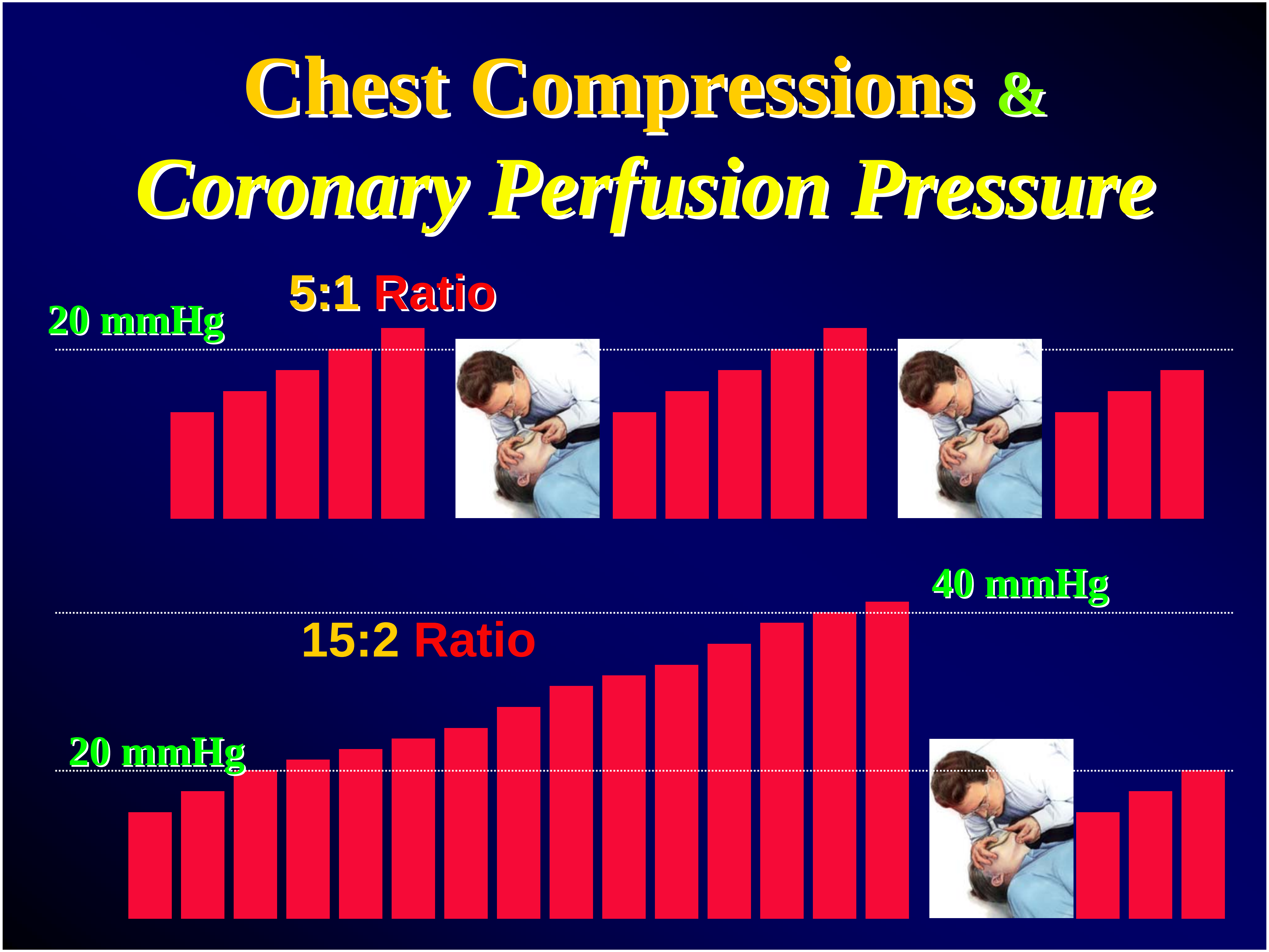
Much of what we do for patients during resuscitation is bad physiology!!

- Positive pressure breaths
- Chest compressions

Breathing the patient too fast INCREASES pressure inside the chest!

It seems that we have been over-ventilating people in circulatory collapse for years

Coronary perfusion pressure drops with over-ventilation


Chest Compressions &
Coronary Perfusion Pressure
5:1 Ratio
20 mmHg
40 mmHg
15:2 Ratio
20 mmHg

Venous return drops with over-ventilation

Intrathoracic pressure is raised with over-ventilation

Sanders, *et al*

- **15:2** (**e.g.,** ***former standard CPR***)
- **50:5** (**e.g.,** ***Great Britain***)
- **CC** (***chest compressions*** **only**)
- **4 min CC only;** ***then*** **100:2**

Neurological Outcomes...

- **4 min CC only; *then* 100:2** ***Did Significantly Better than*** **15:2 (e.g., standard CPR)**
- **CC (chest compression only) --** ***Did Much Worse***

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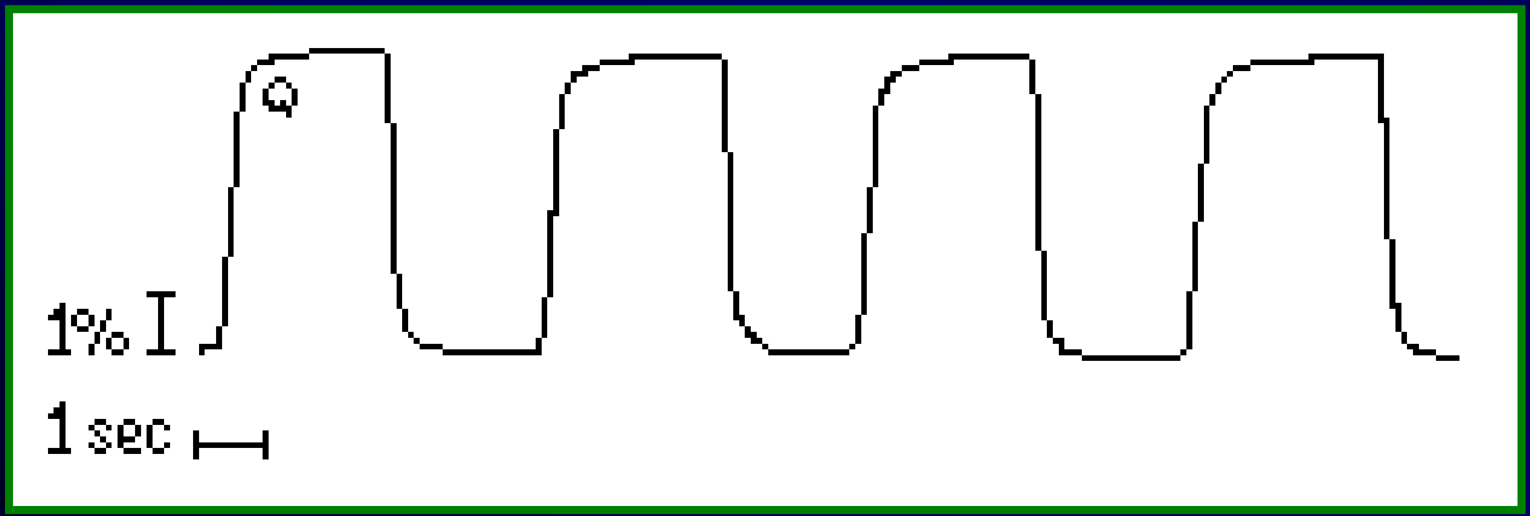
It appears that a one hand squeeze at a rate of one every eight seconds is ALL the ventilation that a patient in circulatory collapse needs!

This is the minute ventilation that you are breathing right now!

About five liters per minute

Breathing the patient faster than that may reduce venous return, worsen shock, and kill the patient!

Let capnography guide you!



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Oridion

First-generation sidestream instruments continuously draw sample gases via an endotracheal tube adapter, through a sampling tube, to an IR light source and detector within a remote bedside monitor.

Sidestream sampling tubes and adapters frequently become clogged and contaminated by respiratory secretions unless the tubes are routinely and frequently replaced.

Second-generation mainstream capnographs mount the IR source and detector lateral to an adapter at the end of the patient's endotracheal tube.

Microstream® technology addresses this problem in this way:

The filter line airway adapters collect air from the middle, not the side, of the air stream through three hollow sampling ports oriented in different directions.

Microstream® technology:

Minimizes aspiration of secretions in the device and makes sampling less dependent on patient posture and device orientation.

Colorimetric method

- A (purple) = < 4 mm Hg
- B (tan) = 4-15 mm Hg
- C (yellow) = > 15 mm Hg

Physiology Reminder

Oxygen -> lungs -> alveoli -> blood

Oxygen

muscles + organs

Oxygen

cells

Oxygen

+

Glucose

energy

CO_2

blood

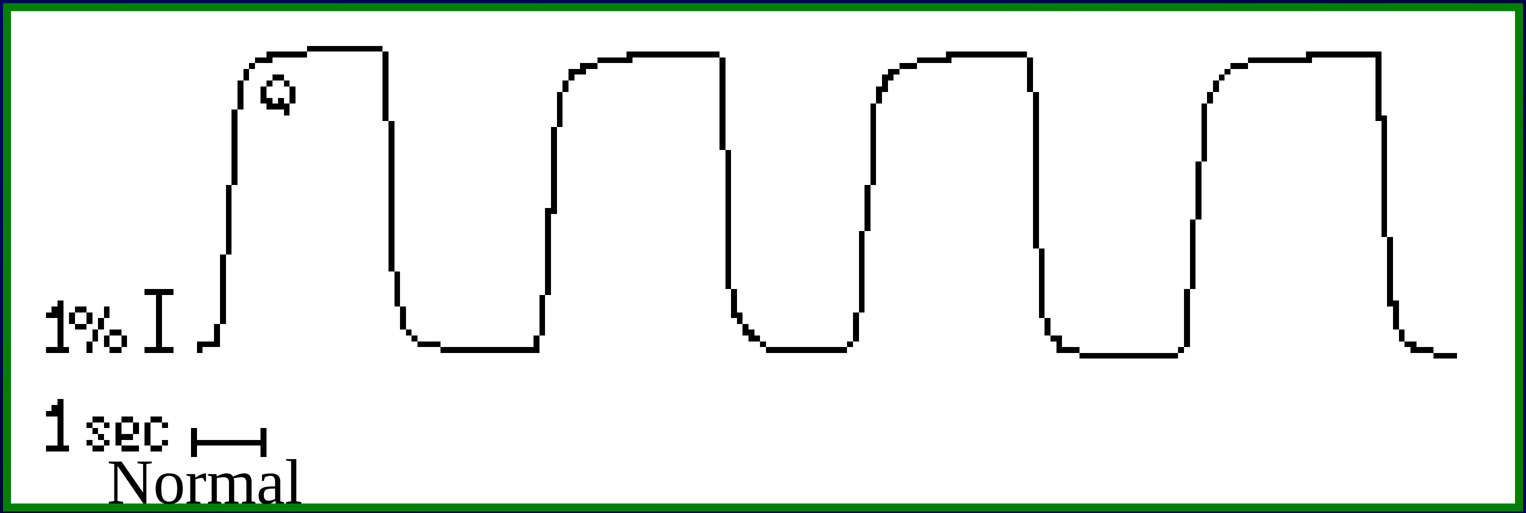
CO_2

lungs

CO_2

breath

Normal Capnogram



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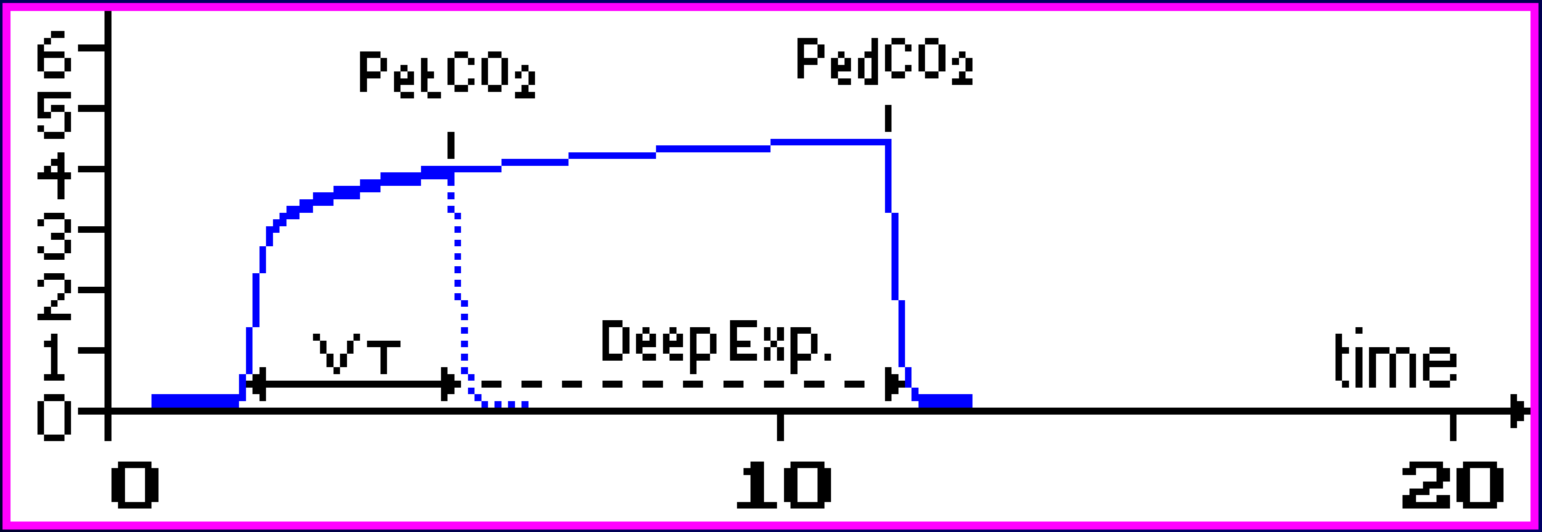
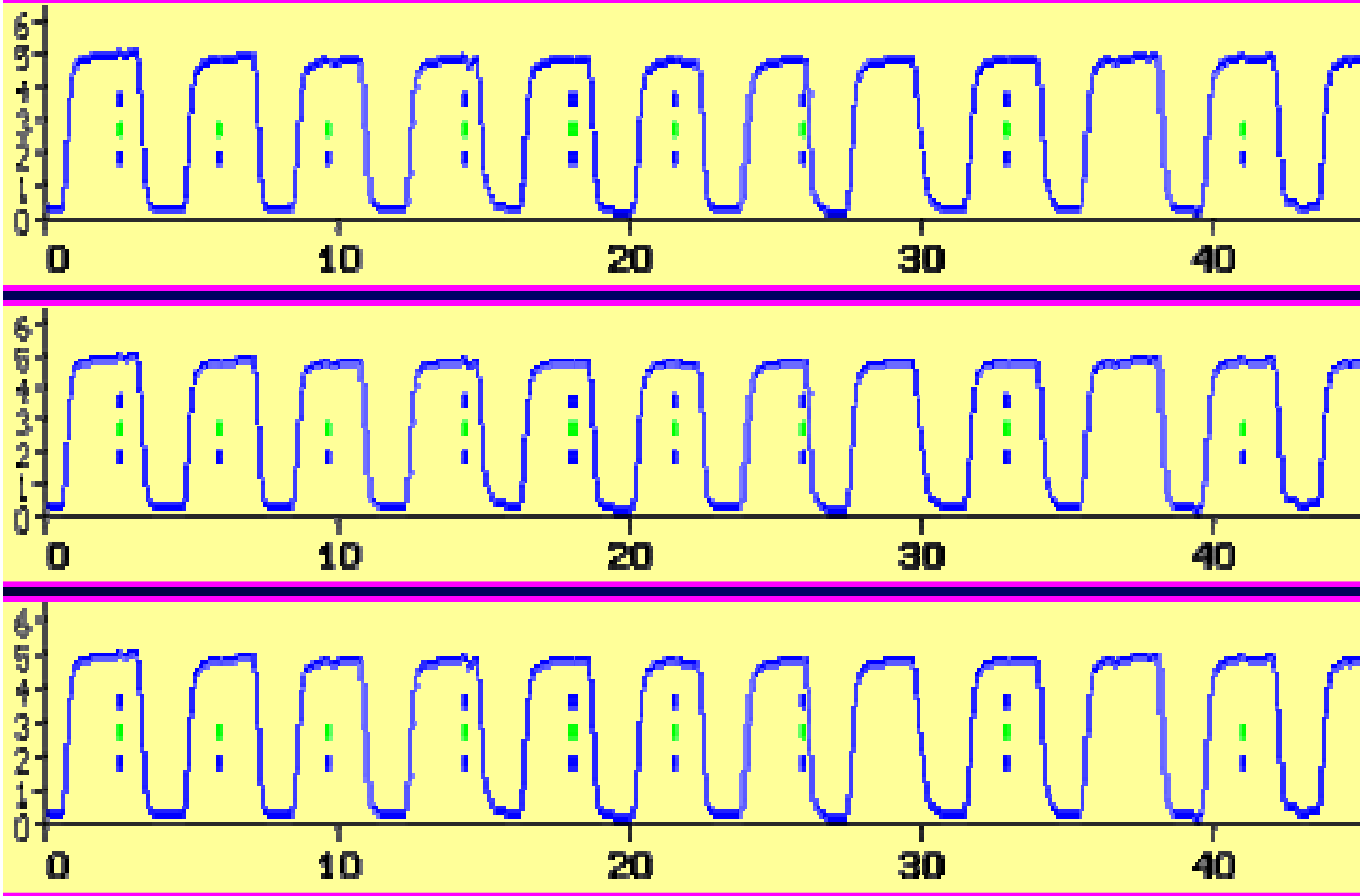
Prolonged Exhalation Capnogram





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Capnography shows:

1. Is the airway in?
2. What's the shape?
3. What's the absolute height of the wave?

Capnography:

1. Verification
2. Bronchoconstriction
3. Circulatory collapse

Quick Review of Causes of a Decreased $EtCO_2$

- Decreased Metabolism
  - Analgesia / sedation
  - Hypothermia
- Circulatory System
  - Cardiac arrest
  - Embolism
  - Sudden hypovolemia or hypotension
- Respiratory System
  - Alveolar hyperventilation
  - Bronchospasm
  - Mucus plugging
- Equipment
  - Leak in airway system
  - Partial airway obstruction
  - ETT in hypopharynx

Quick Review of Causes of an Elevated $EtCO_2$

- Increased Metabolism
  - Pain
  - Hyperthermia
  - Malignant hyperthermia
  - Shivering
- Circulatory System
  - Increased cardiac output with constant ventilation
- Respiratory System
  - Respiratory insufficiency
  - Respiratory depression
  - Obstructive lung disease
- Equipment
  - Defective exhalation valve
  - Exhausted CO_2 absorber

Misplaced Endotracheal Tubes by Paramedics in an Urban EMS System

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Misplaced Endotracheal Tubes by Paramedics in an Urban EMS System

Of 108 patients presenting to their emergency department with an endotracheal tube in place, 27 of the tubes were misplaced

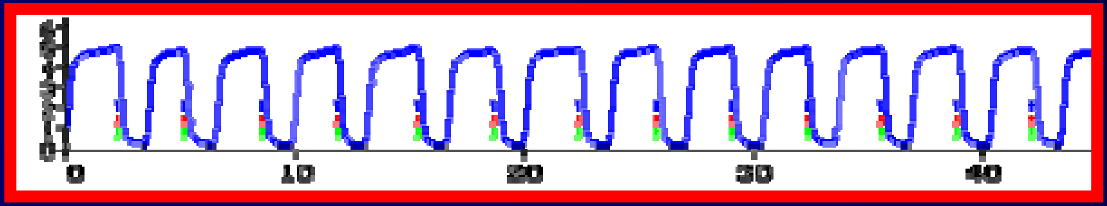
Of the 27 misplaced, 18 were in the esophagus, or 17% of the intubation

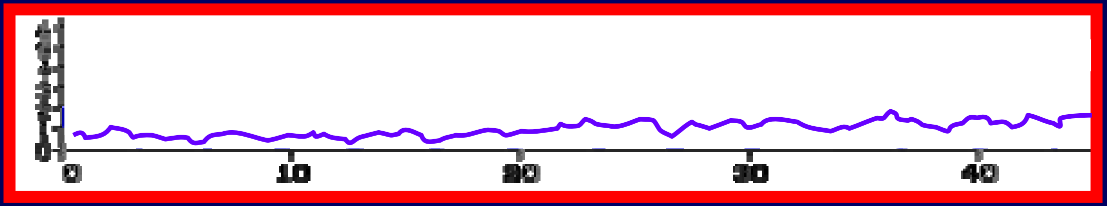
Misplaced Endotracheal Tubes by Paramedics in an Urban EMS System

Conclusions

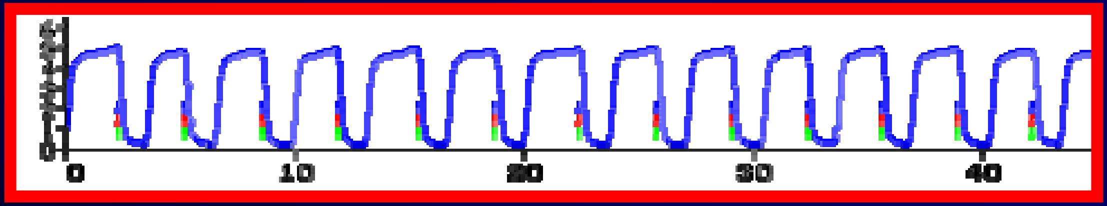
- **Alarming rate of unrecognized, misplaced ETTs in the field**
- **Unique to Orange County?**
- **Under-reported national problem?**

What Happened in Block 2?

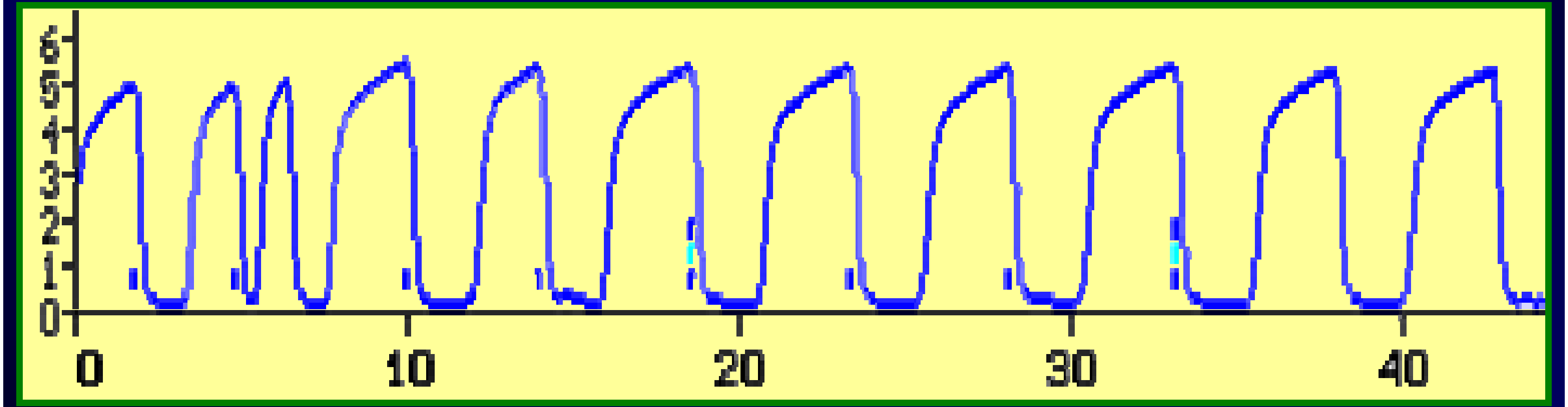




The endotracheal tube became dislodged!



Marked bronchospasm



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Warning, Warning!!!

The Height of the Curve

Non-survivors of Cardiac Arrest
Average ETCO2: 4-10 mmHg

Survivors (to discharge)
Average ETCO2: >30 mmHg

- Flat waveform may indicate PEA if an EKG complex is present
- ROSC shows increasing $ETCO_2$
- Waveform configuration changes with bronchoconstriction

The Impedance Threshold Device

The ITD together with waveform capnography should show an additive effect in improving survival from cardiac arrest


5,692,498; 6,604,523 •


Circulatory

American Heart Association in the 2005 Guidelines recommended slower ventilations during cardiac compressions.

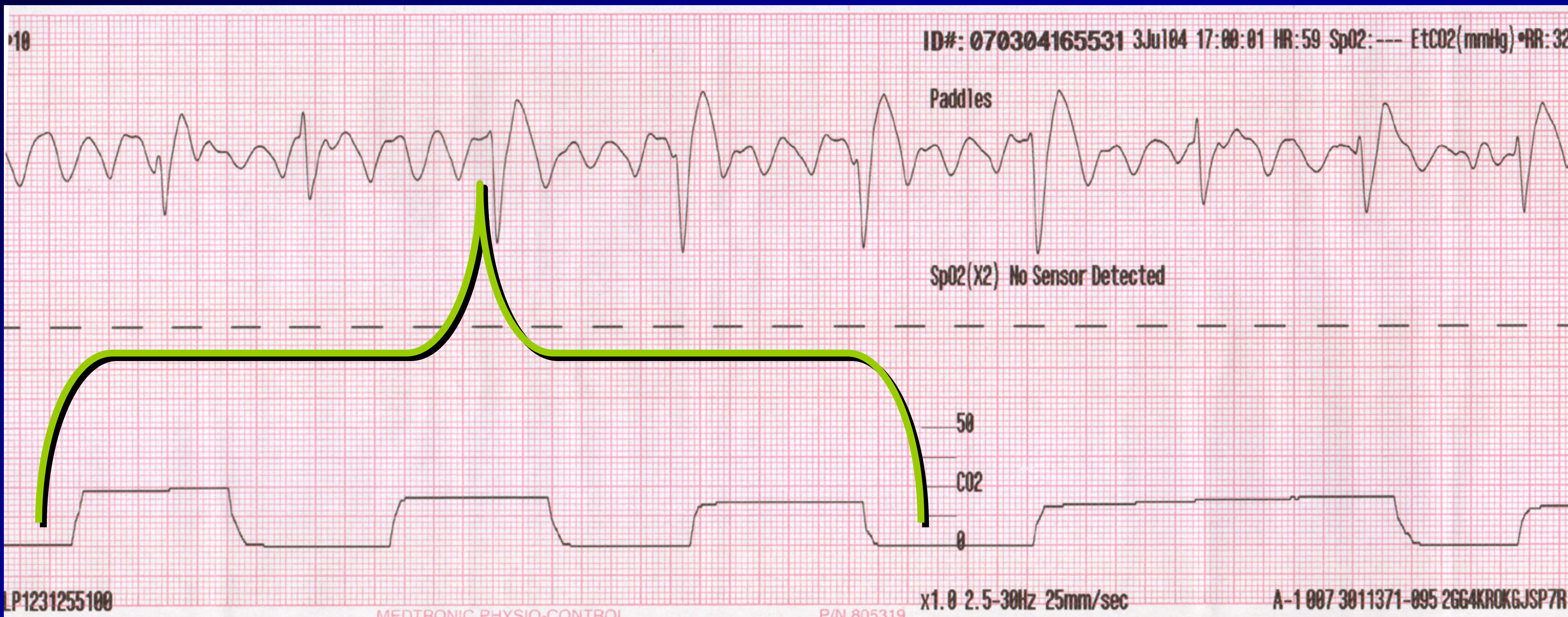
My recommendations

- **Start with the rate of eight, and then measure capnography every five minutes.**

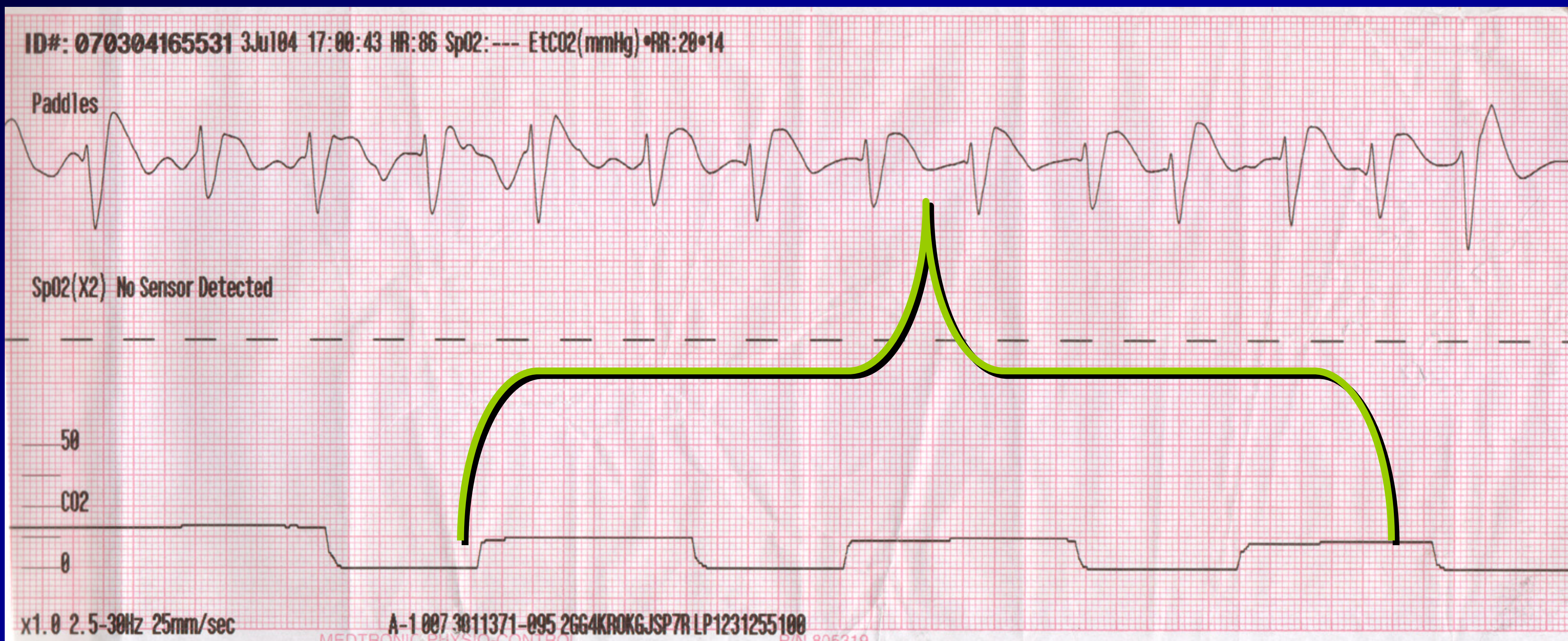
- **If below 20 mmHG CO2, then slow to 1 every 10 seconds.**

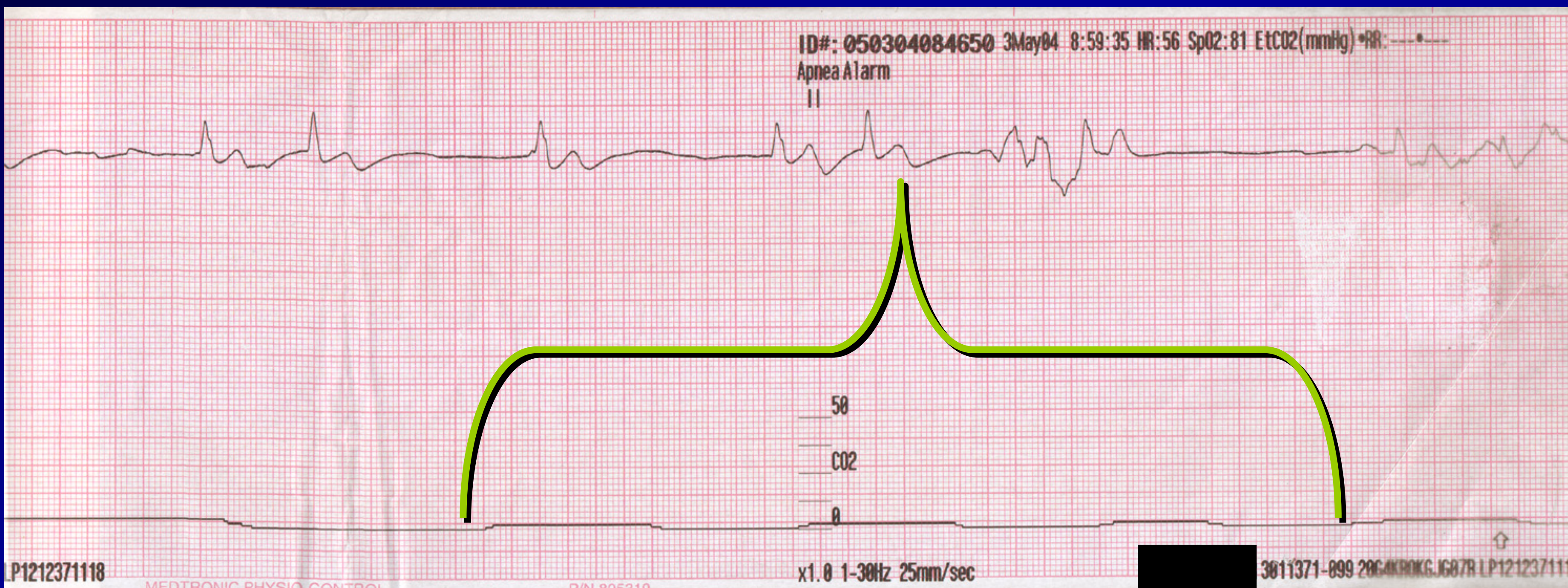
- **If above 40 mmHg CO2, then increase rate to 1 every 6 seconds.**

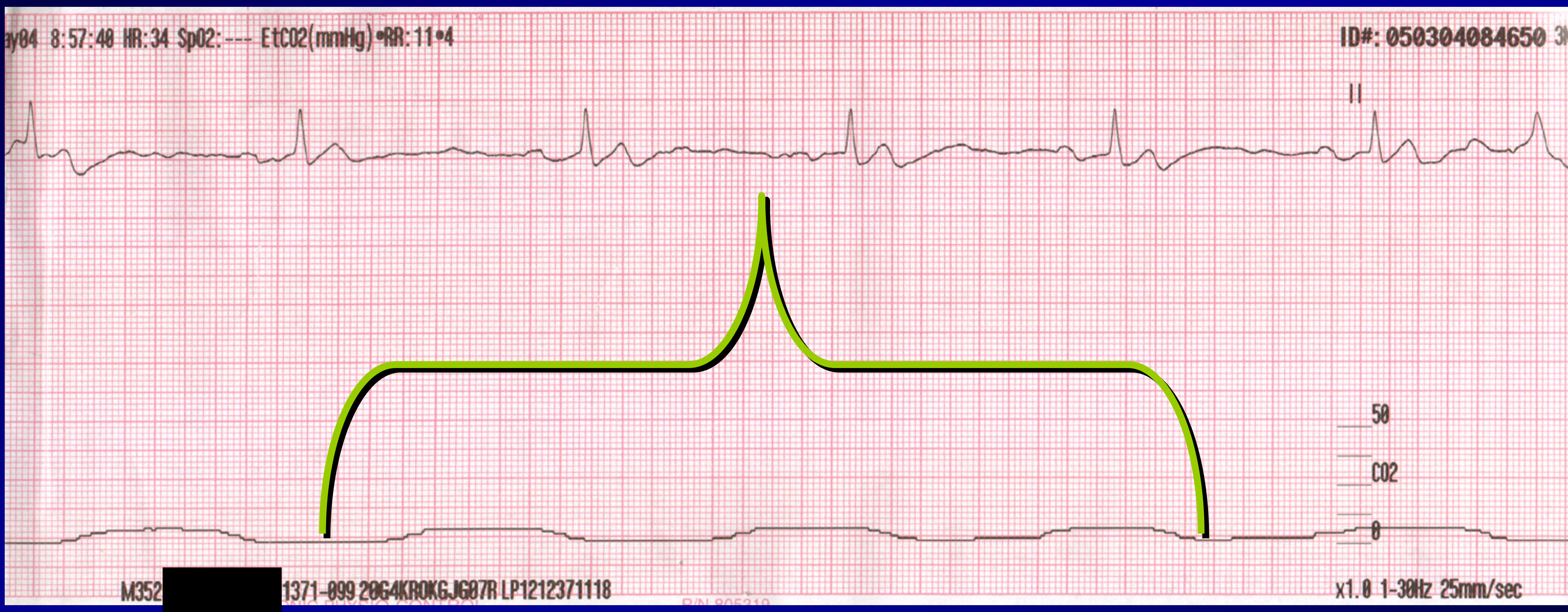

ID#: 070304165531 3Jul04 16:59:09 HR:59 SpO2:--- EtCO2(mmHg)•RR:26•14
Paddles
SpO2(X2) No Sensor Detected
50
CO2
0
x1.0 2.5-30Hz 25mm/sec
A-1 007 3011371-095 2GG4KROKGJSP7R LP1231255100



ID#: 070304165531 3Jul04 17:00:01 HR:59 SpO2:--- EtCO2(mmHg) RR:32
Paddles
SpO2(X2) No Sensor Detected
50
CO2
0
LP1231255100
x1.0 2.5-30Hz 25mm/sec
MEDTRONIC PHYSIO-CONTROL
P/N 805319


ID#: 070304165531 3Jul04 17:00:43 HR:86 SpO2:--- EtCO2(mmHg)•RR:20•14
Paddles
SpO2(X2) No Sensor Detected
50
CO2
0
x1.0 2.5-30Hz 25mm/sec
A-1 007 3011371-095 2GG4KROKGJSP7R LP1231255100
MEDTRONIC PHYSIO-CONTROL
P/N 805319

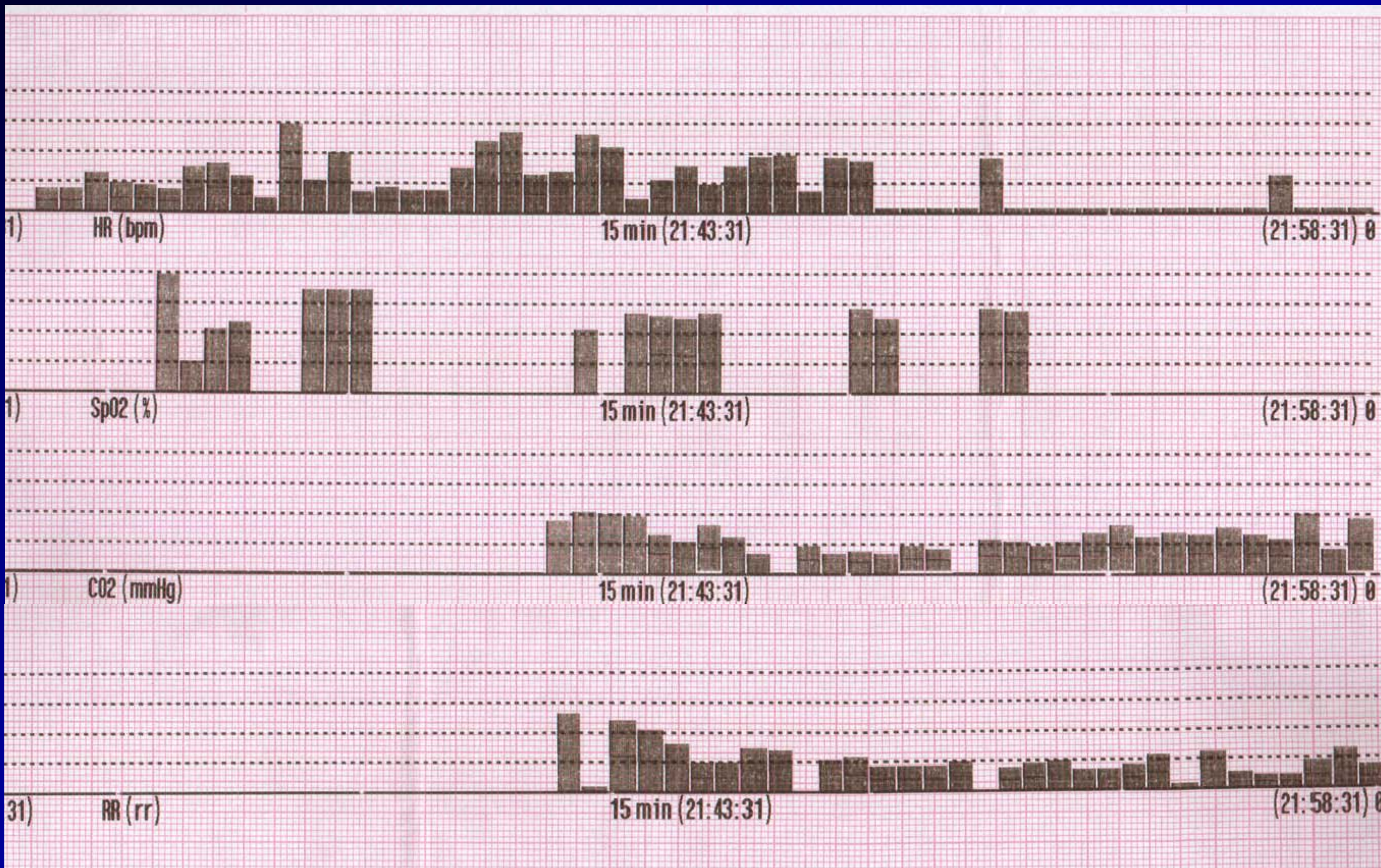

ID#: 050304084650 3May04 8:59:35 HR:56 SpO2:81 EtCO2(mmHg) •RR: ---•---
Apnea Alarm
II
50
CO2
0
LP1212371118
x1.0 1-30Hz 25mm/sec
[redacted]



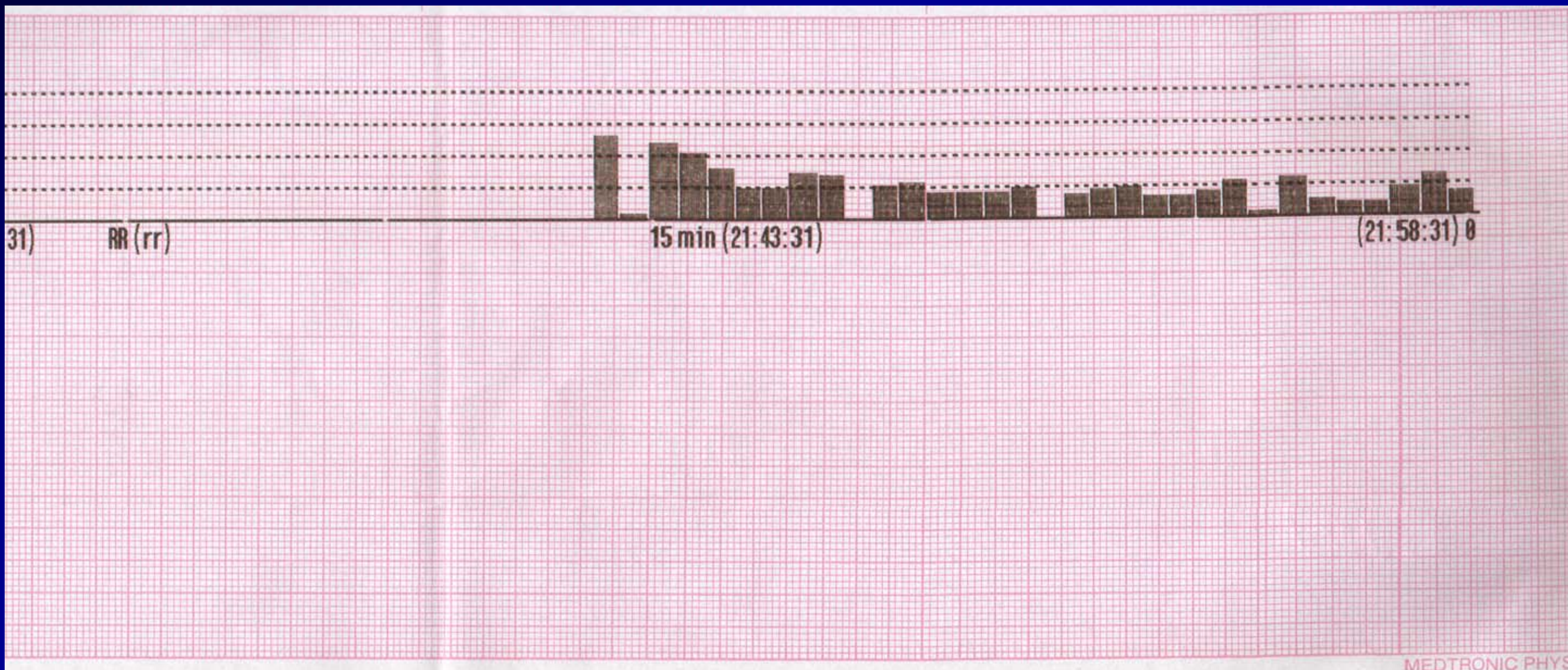
ay04 8:57:40 HR:34 SpO2:--- EtCO2(mmHg) •RR:11•4
ID#: 050304084650 3M
II
50
CO2
0
M352 [redacted] 1371-099 20G4KROKGJG07R LP1212371118
x1.0 1-30Hz 25mm/sec

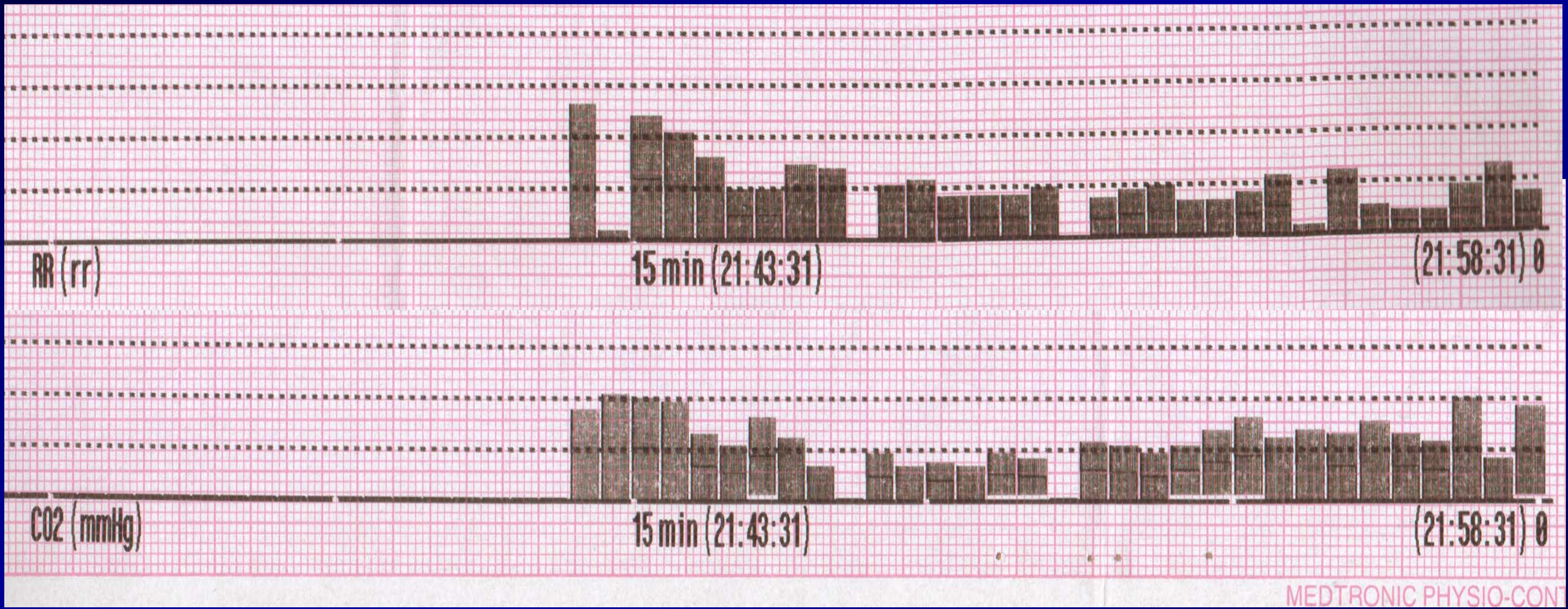
Time	Event	HR	SpO2•PR	EtCO2(mmHg)•RR	NIBP(mmHg)•PR
21:31:31	Power On				
21:31:43	Initial Rhythm				
21:32:03	Shock 1 200J	59	---•---		
21:34:34	Shock 2 300J	60	---•---		
21:36:30	Vital Signs	95	79•132		
21:37:15	NIBP	138	---•---		---/---(---)•---
21:37:51	Lidocaine	52	---•---		
21:38:37	Lidocaine	138	93•45		
21:38:55	NIBP	59	94•38		---/---(---)•---
21:39:32	Shock 3 360J	76	---•---		
21:41:30	Vital Signs	188	---•---		
21:43:12	Shock 4 360J	194	---•---	---•---	
21:44:19	Lidocaine	123	82•237	24•30	
21:46:30	Vital Signs	124	---•---	15•19	
21:47:13	Alarm Apnea	152	---•---	8•18	
21:47:15	Shock 5 360J	155	---•---	---•---	
21:48:33	Alarm Apnea	71	---•---	8•15	
21:50:45	Shock 6 360J	---	---•---	---•---	
21:51:31	Vital Signs	143	85•96	14•10	

Time	Event
21:53:40	AMIODARONE
21:53:58	Shock 7 360J
21:54:41	Shock 8 360J
21:56:31	Vital Signs



1)
HR (bpm)
15 min (21:43:31)
(21:58:31) 0
1)
SpO2 (%)
15 min (21:43:31)
(21:58:31) 0
1)
CO2 (mmHg)
15 min (21:43:31)
(21:58:31) 0
31)
RR (rr)
15 min (21:43:31)
(21:58:31) 0


31)
RR (rr)
15 min (21:43:31)
(21:58:31) 0
MEDTRONIC PHYSI

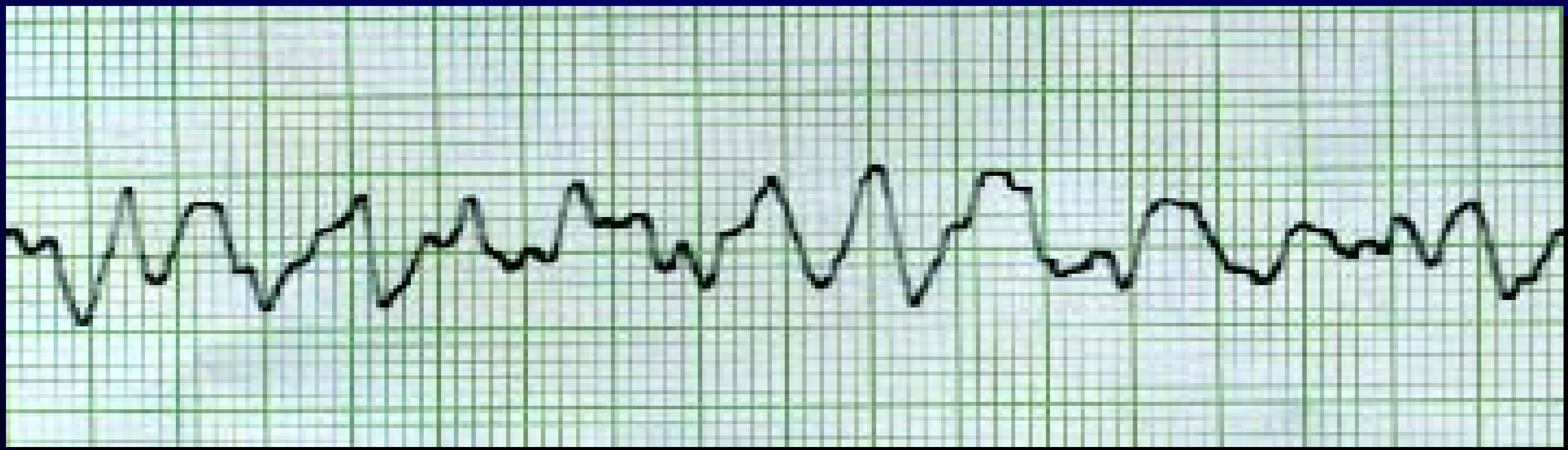

RR (rr)
15 min (21:43:31)
(21:58:31) 0
CO2 (mmHg)
15 min (21:43:31)
(21:58:31) 0
MEDTRONIC PHYSIO-CONT

So, what do we do with this guy??

Make SURE that his ventilation rate is a one hand squeeze every eight seconds

Evaluate capnography or capnometry five minutes later

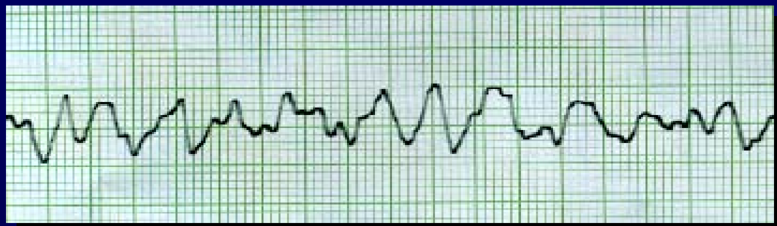
Adjust the ventilation rate from there



…and, if you do this…

<u>…AND YOU MUST…</u>

you will likely be the only guy or gal on the team who understands that this is now the standard

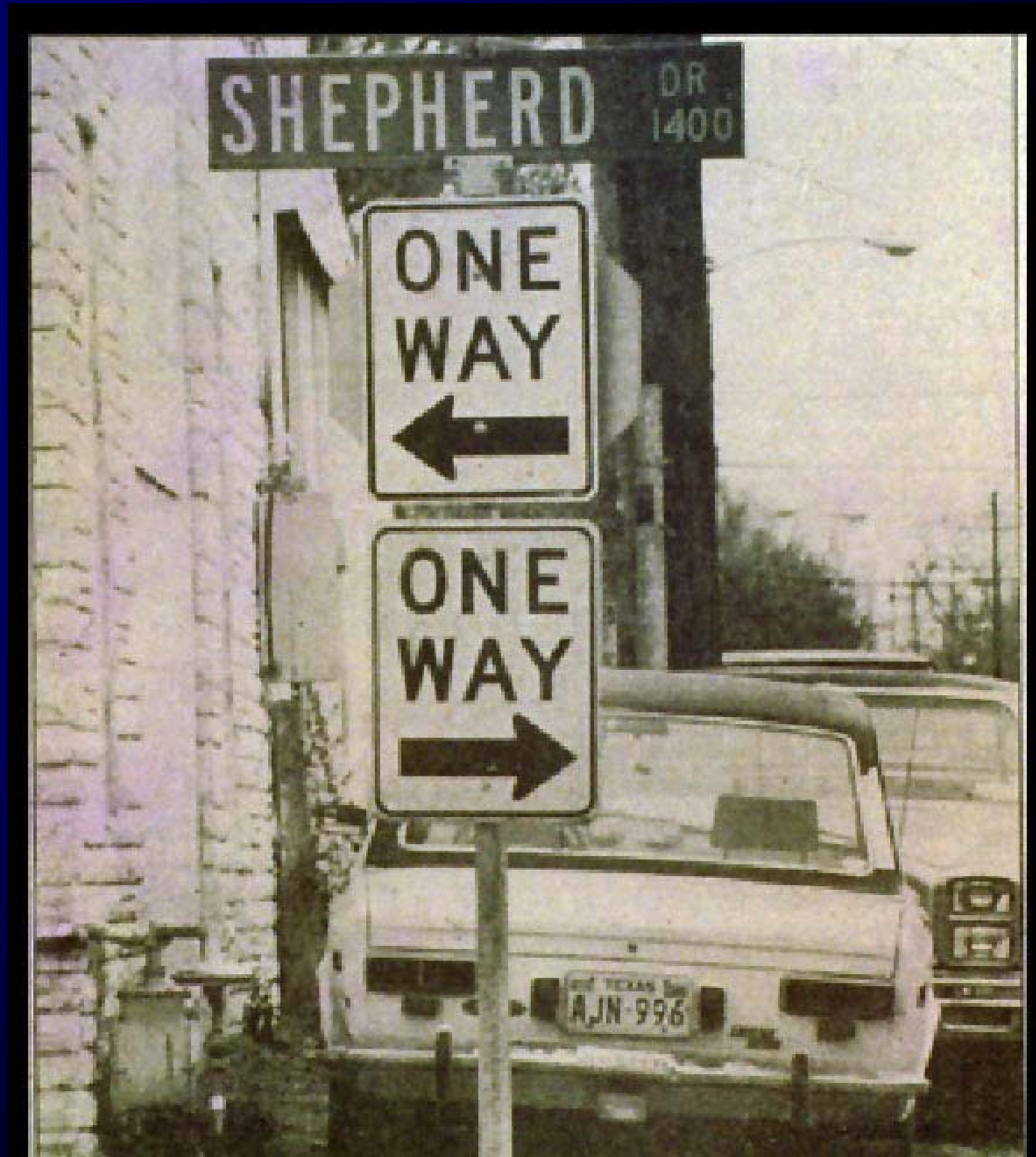


The Objective Question:

What is the relationship
between
exhaled carbon dioxide
and
cardiac output?

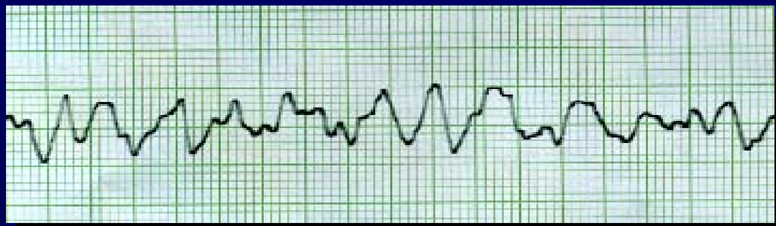
The ANSWER!!

ETCO2 and Cardiac Output are ***DIRECTLY PROPORTIONAL*** when assisting the patient with positive pressure breathing such as Bag to ET tube in cardiac arrest



11/11/2006

EMS is leading the emergency medicine industry in critical care ventilation



Early AHA standards for the use of ventilators during resuscitation required that the ventilator be removed during cardiac compressions

EMS and Mechanical Ventilators

"These devices should be available on every ambulance, and the ability to use ETVs should be part of each EMS provider's skill set."

Wayne, Delbridge, Ornato, Swor et al
Turtle Creek Conference II
PEC Jan-Mar 2001

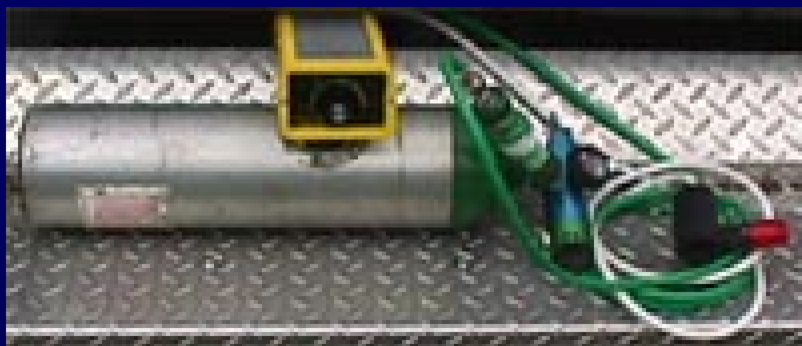
Out-of-hospital ventilation: bag--valve device vs transport ventilator.

Acad Emerg Med. 1995 Aug; Acad Emerg Med. 1995 Aug;2(8):719-24.

Johannigman JA, Branson RD, Johnson DJ, Davis K Jr, Hurst JM.
Department of Surgery, University of Cincinnati Medical Center, OH

A prospective, nonrandomized, convenience sample of 160 patients requiring airway management in the out-of-hospital urban setting, an ABG study on arrival to the ED

When ET intubation was accomplished, adequate ventilation could be achieved using either bag-valve ventilation or a transport ventilator.




12
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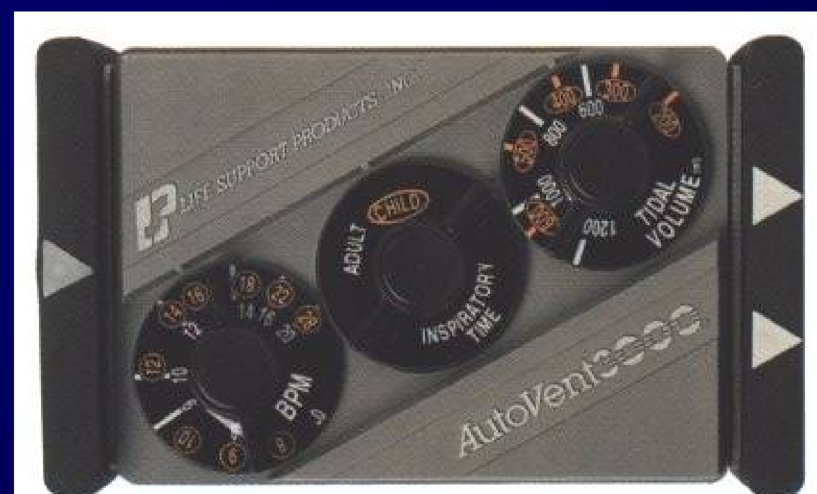
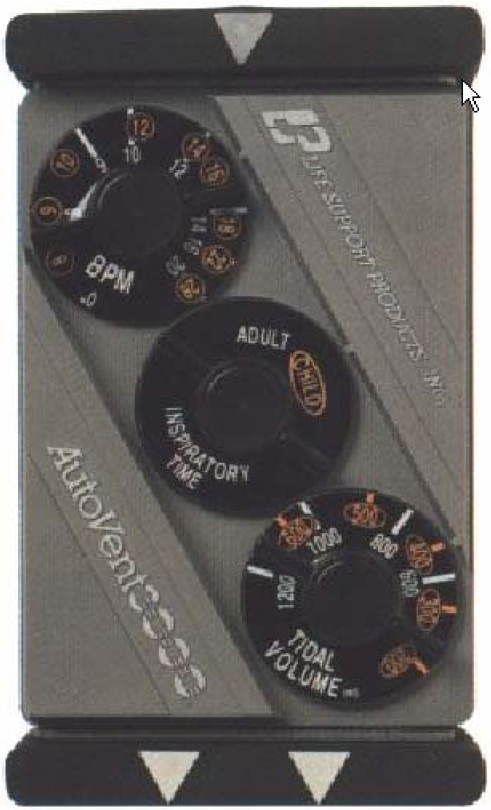
Catalog Numbers & Pricing

OD-2000	Autovent 2000 (Adult)	**$1663.00 ea**
OD-3000	Autovent 3000 (Adult/Pediatric)	**$2510.00 ea**



11/11/2006


LIFE SUPPORT PRODUCTS, INC.
ADULT
CHILD
INSPIRATORY TIME
TIDAL VOLUME
BPM
AutoVent



Product Name: LSP AutoVent 3000 Transport Ventilator

Price: $3195.00

Part Number: LSP-LSP3000

The LSP AutoVent 3000 is a portable, compact emergency transport ventilator with a variety of applications from industrial and volunteer EMS use to air and ground transport. Offering controlled ventilation at rates of 8-28 breaths per minute as well as additional inspiratory time settings, the AutoVent meets most critical emergency care situations and in-hospital transports.

The AutoVent 3000 comes with the LSP patient valve and supply tubing, the control module, six feet of oxygen hose, a non-rebreathing valve (to attach Peep), and connecting tubing. The attached patient valve allows a patient to draw supplemental gas flow (up to 48 LPM) with a spontaneous effort. The AutoVent is available as an anti-inhalation valve for use in toxic environments. The ventilator operates exclusively on source gas with no air entrainment, so specified concentrations of oxygen can be easily maintained.

Specifications

Control Module:
Supply Pressure Range: 40 to 90 psig

Storage Temperature: -40°F to 160°F

Frequency: 8 to 28 BPM

Tidal Volume: 200 to 1200 ml.

Flow Rate: 16 to 48 LPM

Inspiratory Time: .75 - 1.5 seconds

Expiratory Time: 1.5 to 6.0 seconds

I:E Ratio: 1:1 to 1:4

Dead Space in Patient Valve Assembly: 8 ml

Weight: 24 oz./680g.

Expiratory Resistance: 5 cm. H20

Minute Volume: 0 to 24 LPM

Case Material: ABS

Input Connection: Plated brass

Output Connectors: Plated brass

Gas Consumption Driving Gas: 0.5 LPM Maximum

Patient Valve Assembly:
Flow: As required in demand valve mode: 0-48 LPM at 50 psig. Depends on volume setting.

Peak Inspiratory Flow: 48 LPM at airway pressure

Delivery
(44 mm I

Crack Pr
(0 to -.8 i

Exhalatio
to 1.5 cm

Gas Consumption Driving Gas: 0.5 LPM Max

Dead Space: 8 ml (excluding mask)

Supply Pressure: 40 to 90 psig

Operating Temperature: -30°F to 125°F

Storage Temperature: -40°F to 160°F

Inlet Fitting: Standard

Filter: 25 Micron Stainless Steel Mesh

Body: Anodized aluminum

Cover: Polycarbonate

Outlet: Polysulfone

Inlet Fitting: Plated brass

D Cylinder holds 425 liters of oxygen, so a full tank could run an Autovent for 800 minutes, or 13 hours

"Ventilation requires attention during initial training, ETVs clearly have a role in the prehospital setting.

Wayne, Delbridge, Ornato, Swor et al
Turtle Creek Conference II
PEC Jan-Mar 2001

"All patients requiring emergency ventilation must be adequately monitored, including continuous monitoring of end-tidal carbon dioxide concentrations."

Wayne, Delbridge, Ornato, Swor et al
Turtle Creek Conference II
PEC Jan-Mar 2001

"Ventilation requires attention during initial training, continuing education and skill reinforcement, and quality review."

Wayne, Delbridge, Ornato, Swor et al
Turtle Creek Conference II
PEC Jan-Mar 2001

LSP Omni-Vent Portable Ventilator

The Omni-Vent is a pneumatic ventilator that provides assist-controlled, continuous flow, IMV and CPAP ventilation modes. This time cycled ventilator features inspiratory/expiratory variable ratios and a pressure relief value. The Omni-Vent D is MRI compatible.

Specifications:

Power: air/oxygen 25 psi to 140 psi

Rate: 1-50 BPM Inspiratory time range 0.2 to 3.0 Expiratory time range 0.2-60 sec.

Volume: 0-1.5L (volume can be limited)

Flow rate: 0-80 LPM

Dimensions: 4"H x 5"W x 7"D

Weight: 4.5 lbs.

Item #	Description	Qty	Price
14219	Omni-Vent	each	$6,353.00

Impact 750 Transport Ventilator

Designed to meet the needs of air medical and critical care transport. Powered with an internal battery, the 750 ventilation modes include Control, Assist-control, SIMV and CMV. All controls are grouped by function. Lightweight, the 750 is a perfect choice for transport ventilation applications. The 750 is EMI/RFI & air medical certified.

Item #	Description	Qty	Price
11688	Impact 750	each	$5,034.00
11690	Adult Disposable Circuit	each	$4.75
11682	Pediatric Disposable Circuit	each	$8.95

Impact 754 Eagle Transport Ventilator

The best critical care transport ventilator on the market. Completely self contained, the Impact 754 Eagle is battery powered, weighs just over 12 lbs. and consumes no gas. Featuring an internal compressor and blender, the Eagle offers PEEP with Controlled Assist, SIMV, CPAP, and CMV (for Apnea backup) ventilation modes. Bright graphic LCD provides monitoring and alarm settings. An interactive demo/teaching mode assures fast startup sequence in as little as three steps. The Eagle is EMI/RFI & air medical certified.

Item #	Description	Qty	Price
11684	Impact 754 Eagle	each	$8,495.00
11690	Adult Disposable Circuit	each	$4.75
11682	Pediatric Disposable Circuit	each	$8.95

ParaPAC 'Medic' Automatic Transport Ventilator (ATV)

The paraPAC™ Medic Ventilator is a compact, easy to use, rugged, gas powered automatic transport ventilator (ATV). Itis unique array of control functions make this product useable in situations from the first responder resuscitation scenario through the hospital transport application. Featuring a 2 point blender with SMMV* functions, this unit meets your controlled ventilation needs at an affordable price.

- *SMMV - Synchronized Minimum Mandatory Ventilation
- Frequency control 8 to 40b/min
- Tidal volume control 1300 to 70ml
- Pressure monitor 0 to 100 cm H_2O
- 2 point blender 100% or 50% O_2
- Adjustable relief pressure with audible alarm 20 to 80 cm H_2O
- Add-on PEEP option 0 to 20 cm H_2O
- Rugged structural foam plastic housing
- Anti-Shock mounting for gauge and internal pneumatics
- Bag options available

Quantity	Item	Description	U/M	Price
	5692	ventilator, pneuPac, carry case for paraPac Medic/Transport	ea	125.00
	6492	ventilator, pneuPac, paraPac, Medic MRI, w/regulator	ea	4070.00

11/11/2006

LSP Manual Transport Ventilator (MTV-100)

- Intelligent flow control
- Accurate, ìflow-restrictiveî delivery
- Pressure limit terminates both pressure and flow at 60cm H2O
- Secondary pressure safeguard prevents pressures from exceeding 80cm H2O
- Anti-asphyxiation protection
- Easy to clean and service
- Compact, lightweight, durable

Quantity	Item	Description	U/M	Price
	3984	ventilator, LSP #576, EMT resuscitator	ea	287.50
	3985	ventilator, LSP #576-010, EMT resuscitator w/6' hose	ea	351.12
	3986	ventilator, LSP #576-020, EMT resuscitator w/6' hose & mask	ea	383.88

ParaPAC EMT Response Kit

Suggested for BLS-trained personnel. Case holds a D-size O2 cylinder (not included). Contents:

- paraPAC Responder
- paraPAC Regulator
- Seal Easyô mask
- Spanner wrench
- Carrying case
- Shoulder strap * Case has hooks for hanging on litter rail
- Weight: 10 pounds

Quantity	Item	Description	U/M	Price
	6283	ventilator, pneuPac, EMT Response Kit, w/0-25 lpm reg., case	ea	1550.00


PEEP / CPAP
PEAK PRESSURE
% OXYGEN
MANDATORY BREATHS
TIDAL VOLUME
RESP RATE
pNeuton

Oxylator EM-100

A "positive pressure" resuscitation and inhalation system that uses a patented, patient responsive technology. It requires no power source other than a 50 PSI supply of compressed oxygen or air.

The Oxylator EM-100 is not a "demand valve" or a "vent", but it is a pressure limited/flow triggered ventilation device designed to replace the BVM during CPR and short transport. It is very small, light weight, rugged, and easy to use/clean.

The Oxylator EM-100 is ideal for confined space or toxic environment extrication/rescue, and offers a hands free ventilation feature that operates "in-sync" with chest compressions.

- Alerts to airway obstruction
- Positive pressure ventilation
- Delivers more consistent AHA required volumes
- Alerts to mask or "tube leak"
- "closed" ventilation
- No stacking occurs
- Reduces gastric ventilation

O-Two MEDICAL TECHNOLOGIES INC

"INNOVATION IN RESUSCITATION"

CAREvent EMT®

Tidal Volume:	0.15 - 0.6 litres
Breaths Per Minute:	20 - 10
I:E Ratio:	1:2
Manual Flow Rate Range:	As per Vt/BPM Control Setting
Input Pressure:	50 PSI (+/- 10 PSI)
Audible Pressure Relief Valve:	60 cm H_2O
Operating Temperature:	-18°C to +50°C (0°F to 122°F)
Storage Temperature:	-40°C to +60°C (-40°F to 140°F)
Relative Humidity for Storage and Operating Use:	15 to 95%
Input Connection:	Fixed
Hose connection to regulator:	9/16 DISS
Patient Valve Dead Space:	8 ml.
Dimensions (inches):	5.5 x 2.5 x 2.9 (approx.)
Dimensions (millimeters):	140 x 63 x 73 (approx.)
Weight:	0.95lbs / 0.43kg

Emergency mechanical ventilation at moderate altitude.

Roeggla M, Roeggla G, Wagner A, Eder B, Laggner AN.
Wilderness Environ Med. 1995 Aug;6(3):283-7.
Department of Emergency Medicine, University of Vienna, Austria.

To evaluate the influence on minute ventilation and blood gas analysis of moderate altitude (3000 m) compared to 171 m in healthy volunteers during mechanical ventilation

At 3000 m, the delivered minute volume increased by 9.8% in the air mix mode and by 14.6% in the no air mix mode.

Emergency mechanical ventilation at moderate altitude.

Roeggla M, Roeggla G, Wagner A, Eder B, Laggner AN.
Wilderness Environ Med. 1995 Aug;6(3):283-7.
Department of Emergency Medicine, University of Vienna, Austria.

These changes are of sufficient magnitude and importance to require monitoring of minute volume to prevent barotrauma or volume-related trauma and to monitor oxygenation by pulse oximetry during emergency mechanical ventilation at moderate altitude.

Endotracheal intubation in the field does not improve outcome in trauma patients who present without an acutely lethal traumatic brain injury.

Bochicchio GV, Ilahi O, Joshi M, Bochicchio K, Scalea TM.
J Trauma. 2003 Feb;54(2):307-11.
R Adams Cowley Shock Trauma Center
and University of Maryland Medical School

191 consecutive patients admitted to the trauma center with a field Glasgow Coma Scale score < or = 8 and a head Abbreviated Injury Scale score > or = 3 who were either intubated in the field or intubated immediately at admission to the hospital.

Endotracheal intubation in the field does not improve outcome in trauma patients who present without an acutely lethal traumatic brain injury.

Bochicchio GV, Ilahi O, Joshi M, Bochicchio K, Scalea TM.
J Trauma. 2003 Feb;54(2):307-11.
R Adams Cowley Shock Trauma Center
and University of Maryland Medical School

Prehospital intubation is associated with a significant increase in morbidity and mortality in trauma patients with traumatic brain injury who are admitted to the hospital without an acutely lethal injury.
A randomized, prospective study is warranted to confirm these results.

- **Mechanical ventilation works**
- **It decreases rescuer fatigue**
- **It gives consistent breaths**
- **It ain’t a free lunch**

Mechanical ventilation does not in ANY way decrease the need for monitoring of the airway

Mechanical ventilation can be a method to prevent over-ventilation during circulatory collapse

And…

<u>we need more data on their use during low flow states such as shock and cardiac arrest</u>

Synthesis

As EMS professionalism continues to grow….

You, the heroes of the streets, must work harder each day to stay on top of skills

Because, someone out there…

…is waiting to be cared for by you…

Thank you for your kind attention!

Links to follow!!!

drray@doctorfowler.com

www.rayfowler.com

www.utsw.ws