When every breath counts

MICROSTREAM® CAPNOGRAPHY:
The use and benefits in intubated and nonintubated patients

Troy Smith
LT/PM SCFD 7

Microstream®
CAPNOGRAPHY SOLUTIONS

Course Overview

- Capnography Overview
- Physiology
- Oxygenation vs. Ventilation
- History of Capnography

Course Overview

- Technology Advances
- Understanding the Waveform
- Capnography uses in EMS Intubated uses
- Non-intubated uses

Capnography Overview

Why use capnography?

Why should I learn capnography?

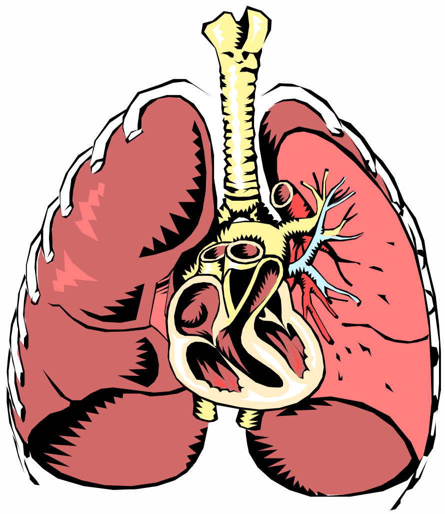
Capnography Overview

- End Tidal CO_2 -What is It?
  - Breathing is done in waves
  - $EtCO_2$ is the amount of CO_2 measured at the peak of the wave
  - $EtCO_2$ is measured at nose, mouth, or hub of the ET tube

Capnography Overview

- A technology that
  - Provides another measurement in assessing your patient
  - Gives an objective measure ofyour patient’s ventilatory status
  - Shows a graphic picture of your patient’s ventilatory status
  - Presents an early warning of changes in your patient's cardiopulmonary status
  - Supplies important documentation on your patient

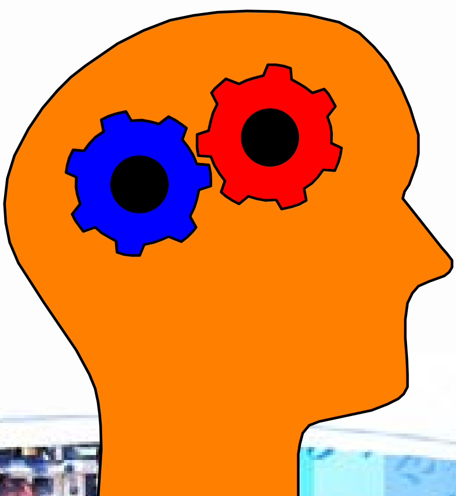
PHYSIOLOGY



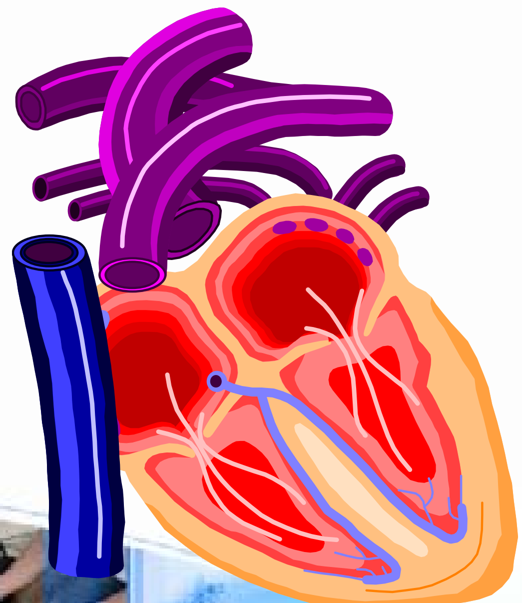
Physiology of CO_2

ALL THREE ARE IMPORTANT!

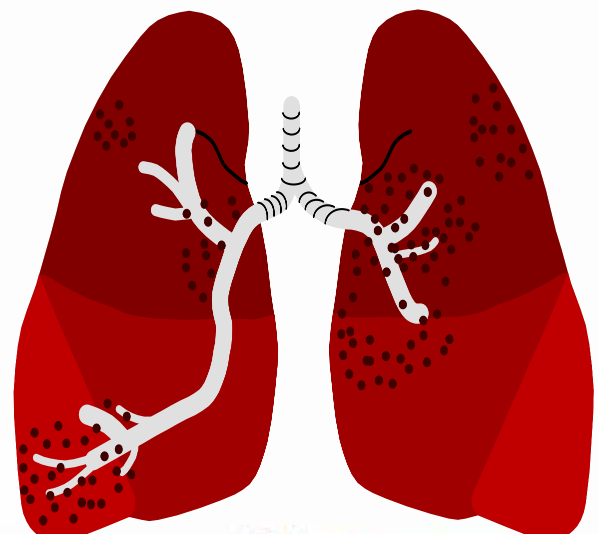
METABOLISM



PERFUSION



VENTILATION



Physiology of Carbon Dioxide Production

Oxygen-> lungs -> alveoli -> blood

Oxygen

muscles + organs

Oxygen

cells

Oxygen + Glucose

energy

CO_2

blood

CO_2

lungs

CO_2

breath

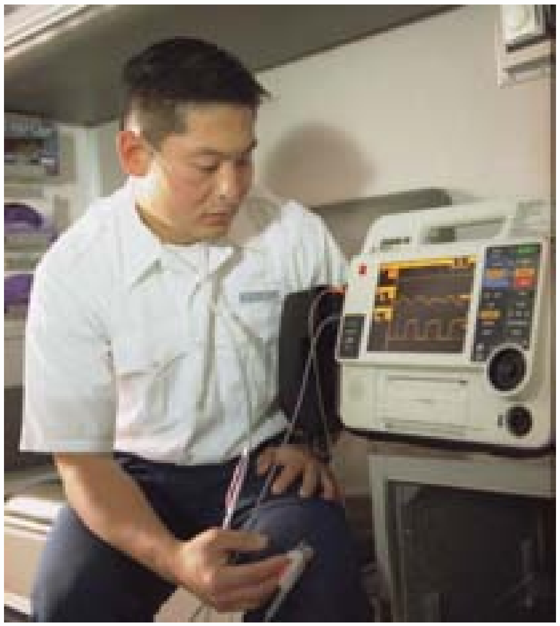
The Relationship Between $PaC0_2$ and $EtC0_2$

- $EtCO_2$ normal range is 35 - 45 mmHg
- Under normal ventilation and perfusion conditions, the $PaCO_2$& $EtCO_2$ will be very close
  - 2 - 5 mmHg with normal physiology
- Wider differences found in abnormal perfusion and ventilation

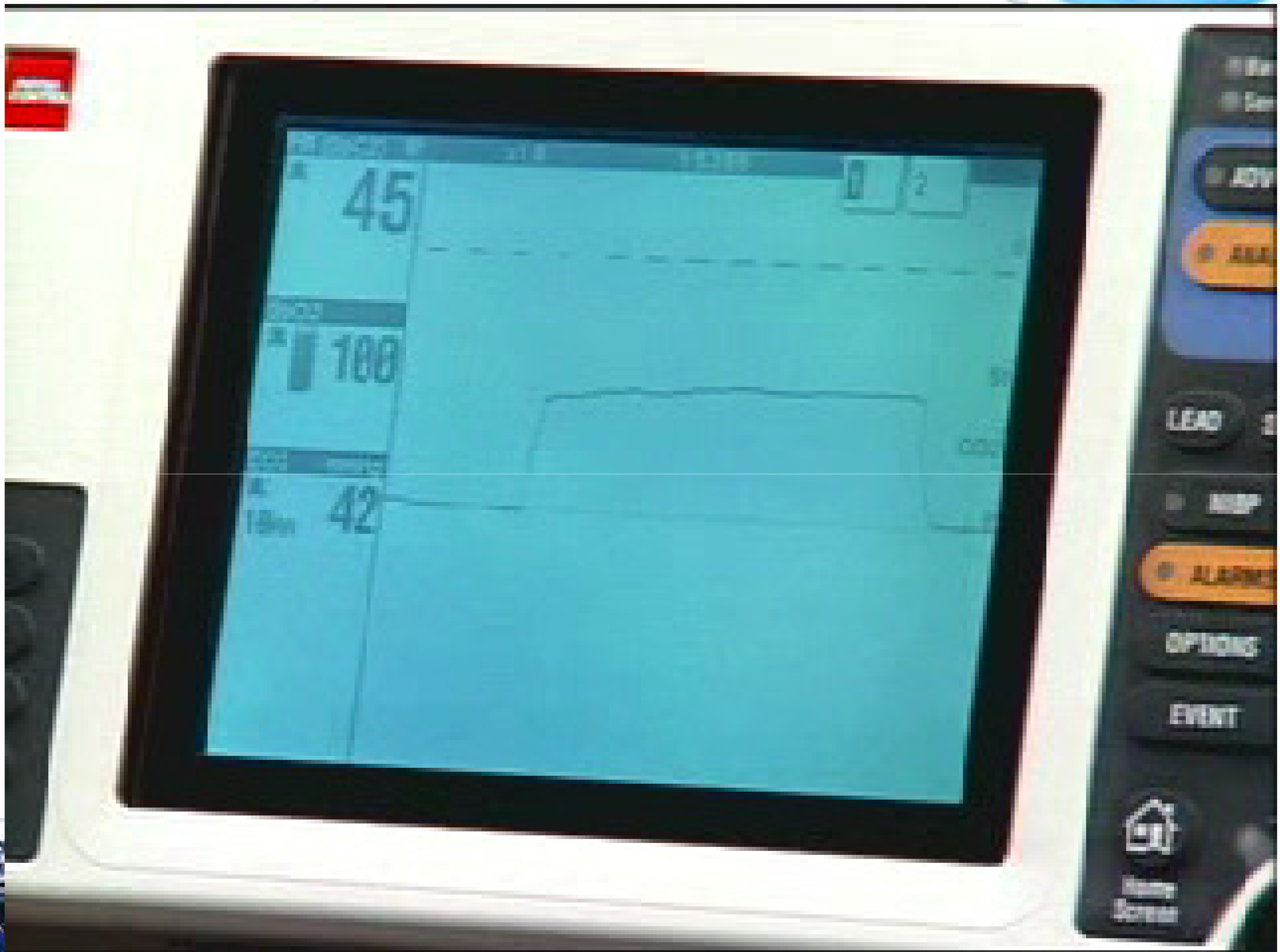
Oxygenation and Ventilation

What is the difference?

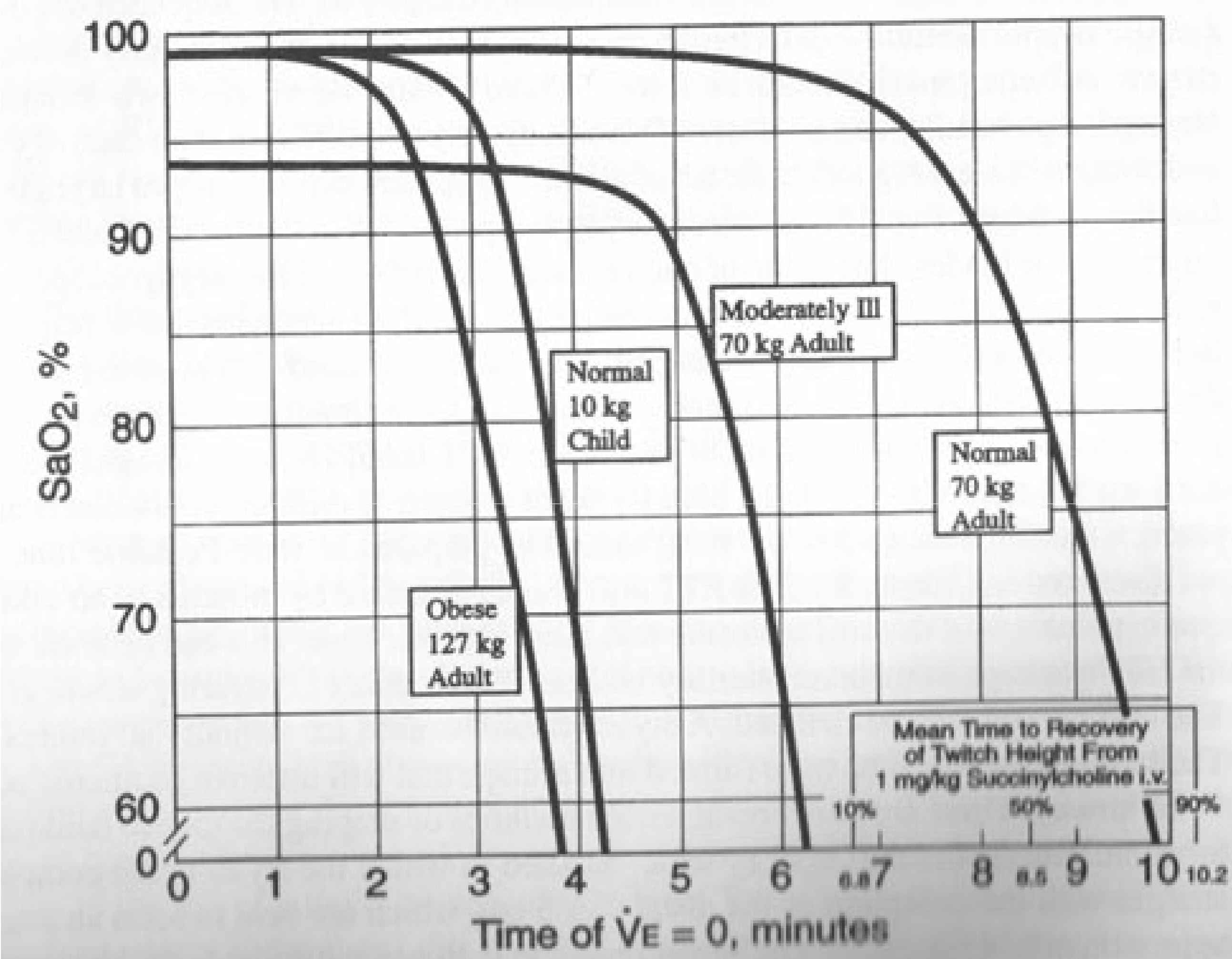
Oxygenation versus Ventilation



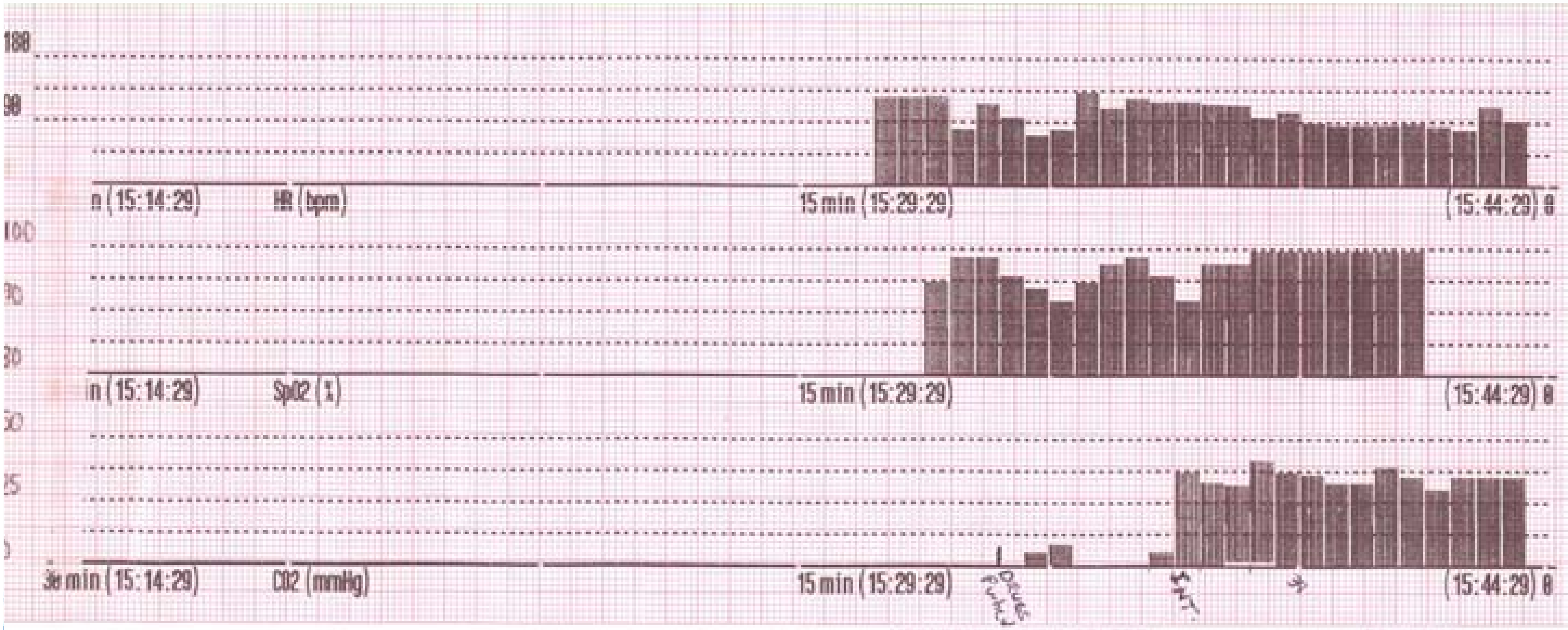
- Monitor your own SpO_2 and $EtCO_2$
- SpO_2 waveform is in the second channel
- $EtCO_2$ waveform is in the third channel


45
100
42
LEAD
NIBP
ALARMS
OPTIONS
EVENT

Oxygen Desaturation Curve



Trend Summary Desaturation



Oxygenation and Ventilation

- Oxygenation
  - Oxygen for metabolism
  - SpO_2 measures % of O2 in RBC
  - Reflects change in oxygenation within 5 minutes
  - Sensitive to artifact, motion, poor perfusion
- Ventilation
  - Carbon dioxide from metabolism
  - $EtCO_2$ measures exhaled CO_2 at point of exit
  - Reflects change in ventilation within 10 seconds
  - Accurate with motion and poor perfusion

History of Capnography in EMS

- Used by anesthesiologists since the 1970s
- Standard of care in the OR since 1991
- New standards and technologies now expanding utilization

Source: PRACTICE GUIDELINES FOR SEDATION AND ANALGESIA BY NON-ANESTHESIOLOGISTS (Approved by the House of Delegates on October 25, 1995, and last amended on October 17, 2001) Anesthesiology 96: 1004-1017, 2002

History of Capnography in EMS

Colorimetric

↓

Capnometry

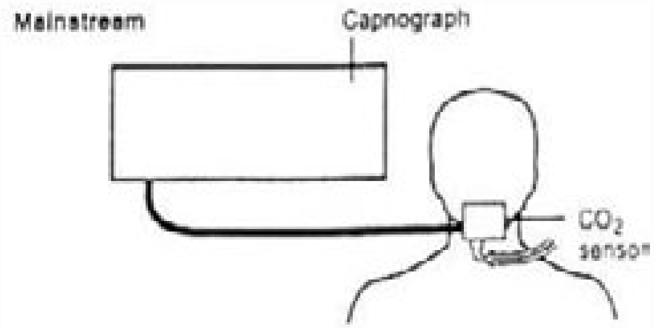
↓

Capnography

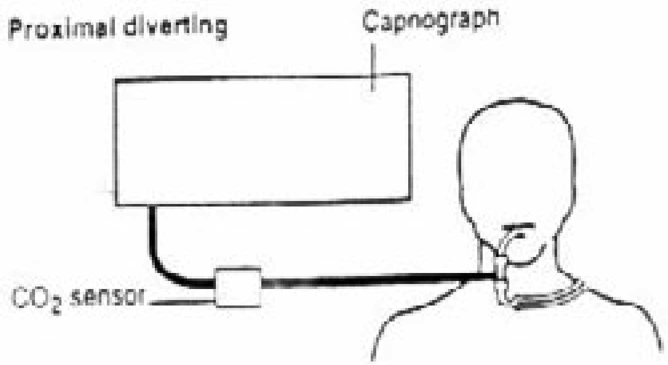
Menu

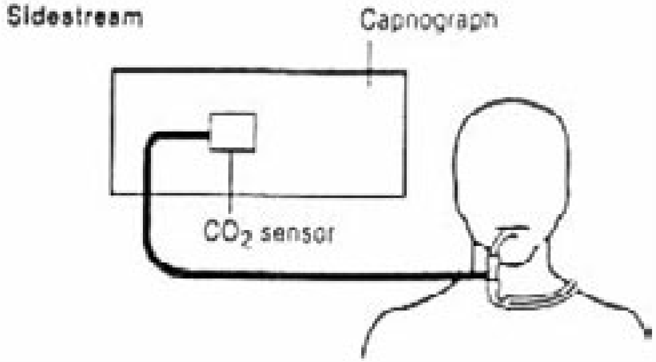
Conventional Technologies

- **Mainstream**



- **Sidestream**





History of Capnography in EMS

Capnography Technologies

- Conventional high-flow sidestream

  ↓ 1980's

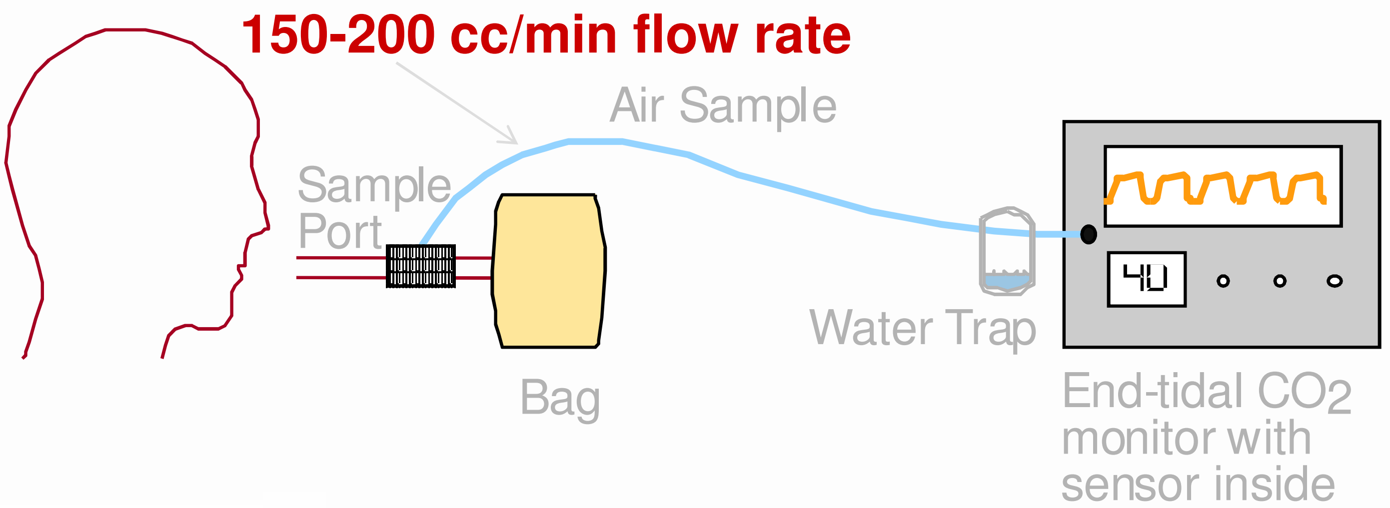
- Mainstream

  ↓ Early 1990's

- Microstream® technology

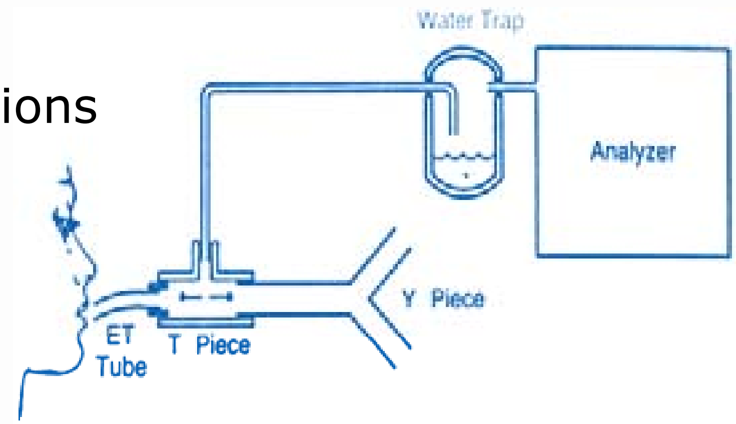
History of Capnography in EMS

Conventional high-flow sidestream capnography system



Conventional Sidestream Technologies

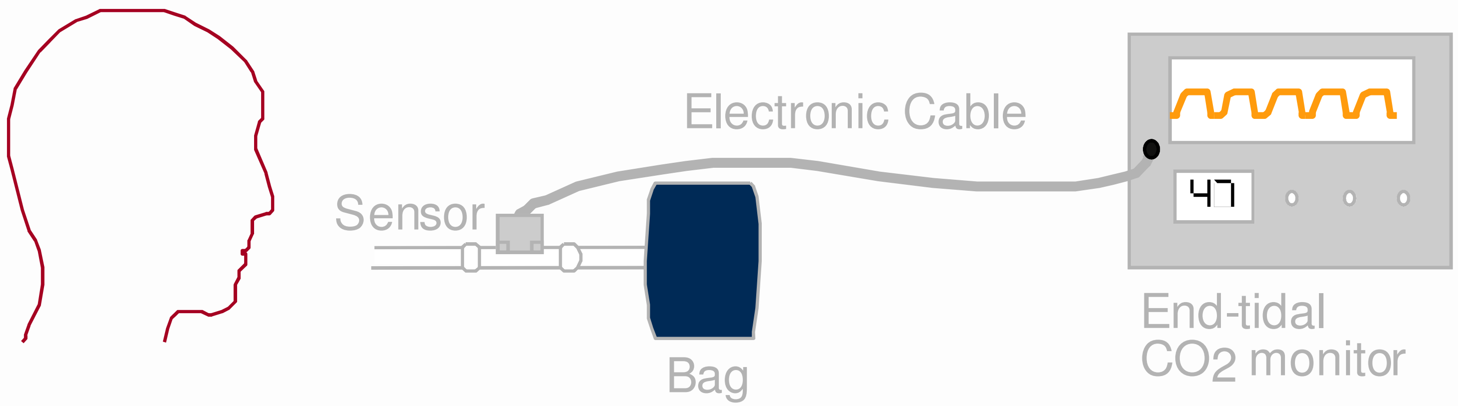
- **Advantages**
  - No sensor at airway
  - Intubated & non-intubated applications



- **Disadvantages**
  - Requires routine zero & calibration
  - Requires high sample flow rate (150-250 ml/min)
  - Secretions block sampling tube
  - Requires external filter & water trap
  - Competes for tidal volume in infants & neonates

History of Capnography

- Mainstream Capnography



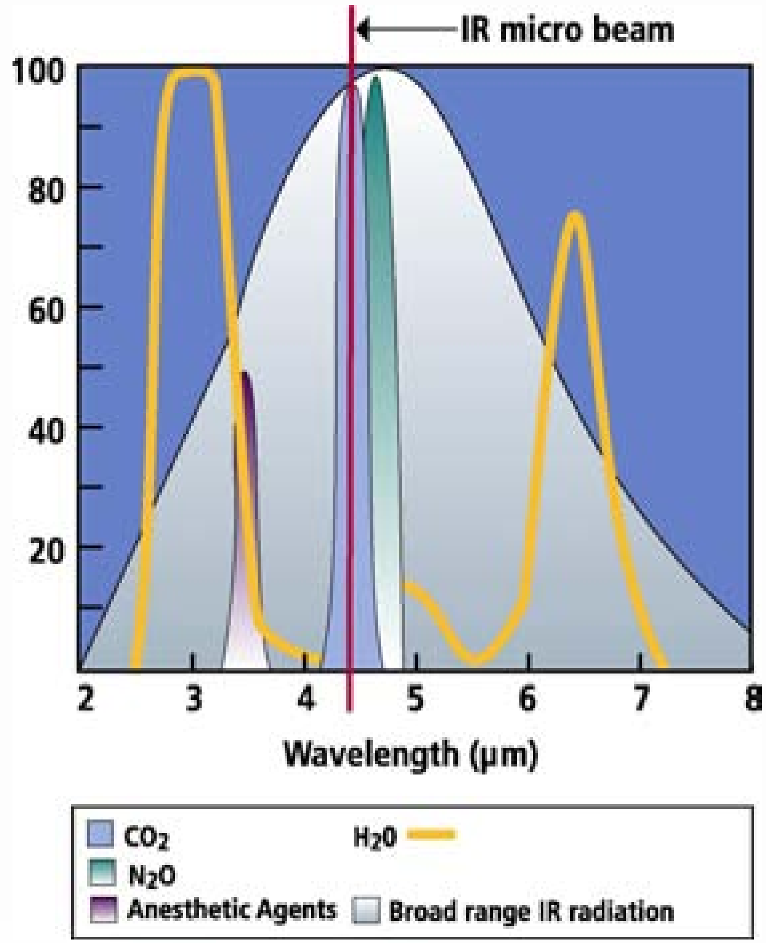
Mainstream Conventional Technology

- **Advantages**
  - Sensor on airway / real time
- **Disadvantages**
  - Requires routine zero & calibration
  - Requires sensor & cable at airway
  - Heavy sensor on the airway
  - Expensive sensor replacement
  - Secretions block sensor window
  - Only intubated patient populations
  - Not able to use on non-intubated patients

Menu

Microstream® Technology

- **Microstream® technology improves upon conventional sidestream technology**
  - Focused CO_2 specific IR beam
    -**Not affected by any other gases**
  - Low sample flow rate
    -50 ml/min
  - Miniature sample cell
    -15 microliters



Microstream® Technology

- **Microstream® technology improves upon conventional sidestream technology**

Advantages

- No sensor at airway
- No routine calibration
- Automatic zeroing
- Neonatal through adult
- Intubated and non-intubated patients
- Promotes superior moisture handling
- Accurate at small tidal volumes and high respiratory rates (pediatrics/neonates)

Microstream®Capnography

- A combination of a unique CO_2 sidestream measurement technology and FilterLine® sampling line for improved breath sampling
- Only system providing accurate $EtCO_2$ readings for non-intubated patients receiving supplemental O_2 and switch between oral and/or nasal breathing

Microstream®Capnography Major Benefits

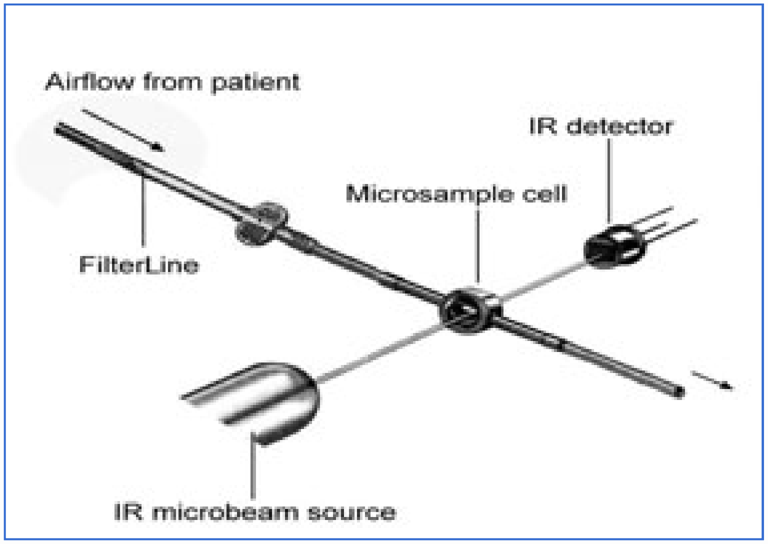
- Ease of use
- Reliable technology
- Flexibility; applicable for all patient types
- Versatile for all care environments
- Latest in capnography technological advancements

Menu

When every breath counts

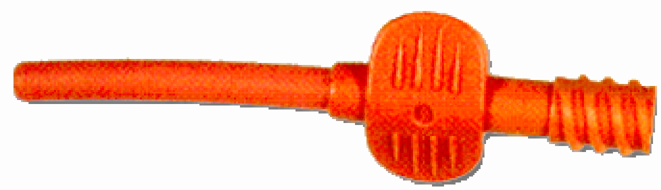
Microstream® Capnography Advantages

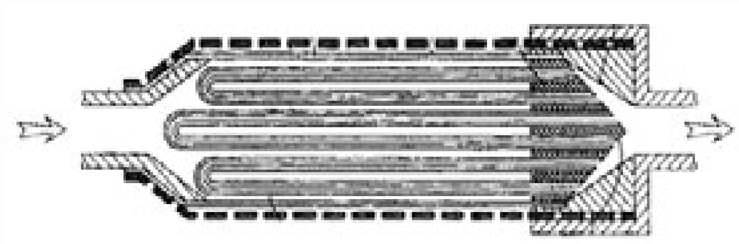
- **Ease of Use**
  - No expensive sensors to replace
  - Yearly calibration – done in 5 minutes by BioMed
  - Quick warm up time ~40 seconds from *ON* until first waveform and number appear
  - One-piece Plug & Play consumables



Microstream® Capnography Advantages

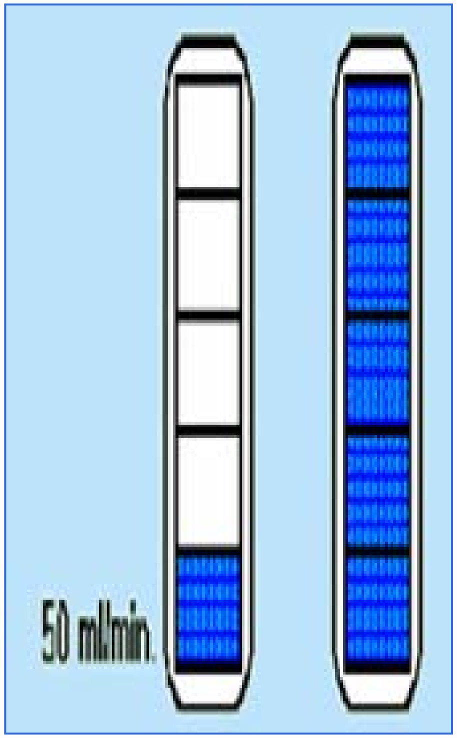
- **Reliable Technology**
  - Fast response time
  - 1 mm microbore tubing reduces delay time
  - Crisp waveform – longitudinal filter maintains laminar flow
  - 0.2 micron Filter (hydrophobic longitudinal hollow fiber filter) prevents liquids from entering into the monitor





Microstream® Capnography Advantages

- **Flexible for all Patient Populations**
  – Solution for monitoring neonates
  - 50 ml/min flow rate supports entire patient population – including neonates, compared to other brands that require 3-4 times the sample flow rate (150-200ml/min)
  - Does not compete for Neonate tidal volume
  - The lower the flow, the less moisture in the sampling line



Menu

FilterLine® Solutions for EMS

Non-Intubated

Intubated

Smart Solutions

Smart CapnoLine® Plus/
Smart CapnoLine® Plus O_2

Smart CapnoLine® Plus
with connector

FilterLine® Sets

Smart Solutions for Non-intubated Patients

- "Microstream® technology allows the accurate measurement of $EtCO_2$ in the absence of an endotracheal tube."

  - Continuous sampling from both mouth and nose
  - Special oral-piece design optimally samples when the patient is mouth breathing
  - Increased surface area provides greater sampling accuracy in the presence of low tidal volumes

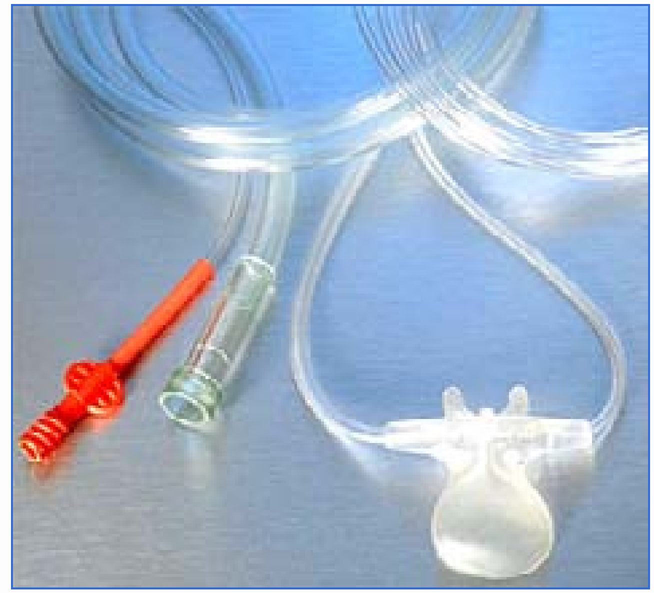
ASA, 2001. Jay Brodsky, MD Professor of Anesthesia, Stanford University Medical Center, CA, USA.

Smart Solutions for Non-intubated Patients

- **"Smart CapnoLine®Plus / Smart CapnoLine®Plus O_2"**

Oral/nasal FilterLine® for CO_2 measurement and O_2 delivery

  - Uni-junction sampling method ensures optimal waveform and ultra-fast response time
  - Unique O_2 delivery method reduces CO_2 sampling dilution
  - Effective O_2 delivery for both low flow and high flow needs

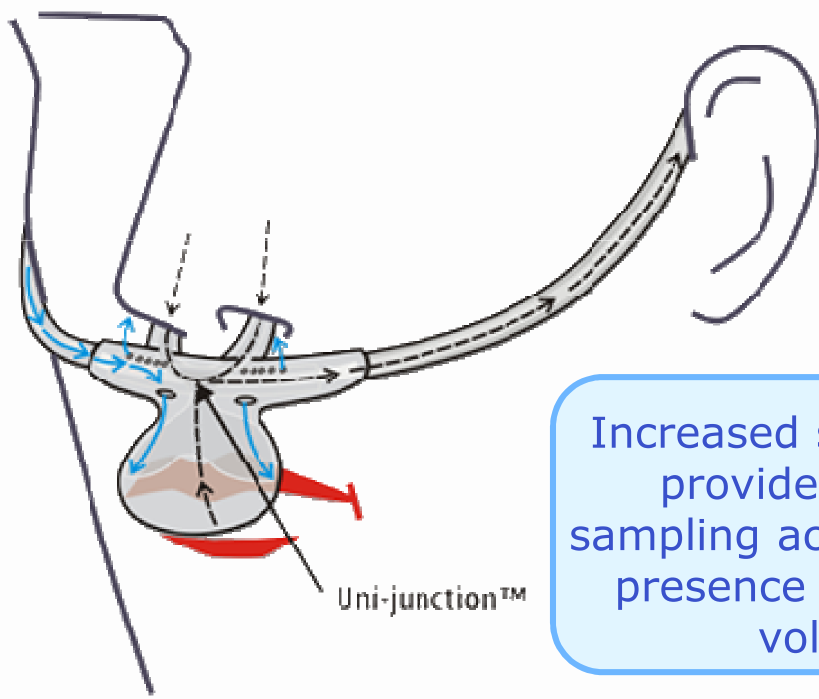


Microstream® Capnography
A Unique Solution for Non-intubatedPatients

- **CO_2 sampling/O_2 delivery for non-intubated patients**

Small pin holes deliver oxygen around both nose and mouth

Uni-junction™ of sampling ports prevents dilution from supplemental oxygen



Increased surface area provides greater sampling accuracy in the presence of low tidal volume

Menu

When every breath counts

FilterLine® Sets - Solutions for Intubated Patients

- Easily handles moisture and secretions without water traps
- Able to measure in any position
- Easily switches to non-intubated monitoring without re-calibration of monitor

Microstream®
CAPNOGRAPHY SOLUTIONS

Menu

When every breath counts

FilterLine® FAQs

- For use only with monitors using Microstream® technology
- Single patient use, latex free
- Do not attempt to disinfect or flush lines
- Securely connect all components
- Never cut any area of a FilterLine® CO_2 sampling line
- Do not instill medications through the airway adapter
- When suctioning or instilling saline, place monitor into standby
- Never pass a suction catheter or stylet through the intubated airway adapter
- Change the FilterLine® CO_2 sampling line when the monitor displays a CO_2 occlusion message

Microstream® CAPNOGRAPHY SOLUTIONS

Microstream®Capnography Solutions for all Applications

"Microstream® features:

- Low flow rates
- Reduced dead space
- Lack of moisture-associated occlusion problems, and
- Low power consumption.

Furthermore, it can be used reliably in both intubated and non-intubated patients."

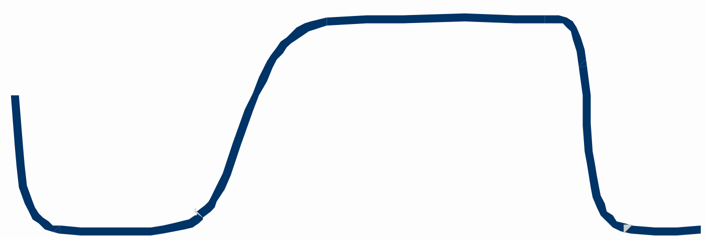
*Journal of Clinical Monitoring and Computing, August 1999. Baruch Krauss, MD, Division of Emergency Medicine, Boston Children's Hospital, Instructor in Pediatrics, Harvard Medical School, Boston, Massachusetts, USA.

Capnographic Waveforms

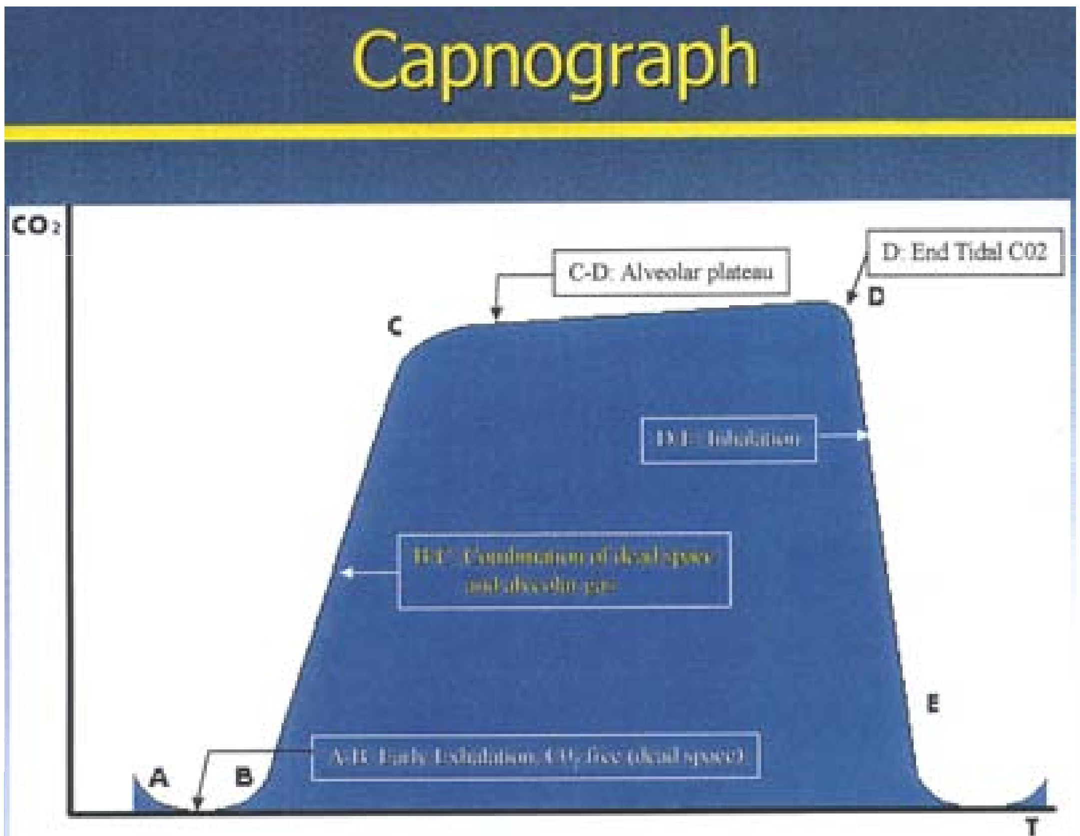
As Diagnostic as an ECG Waveform

Capnographic Waveform

- Normal waveform of one respiratory cycle
- Similar to ECG
  - Height shows amount of CO_2
  - Length depicts time

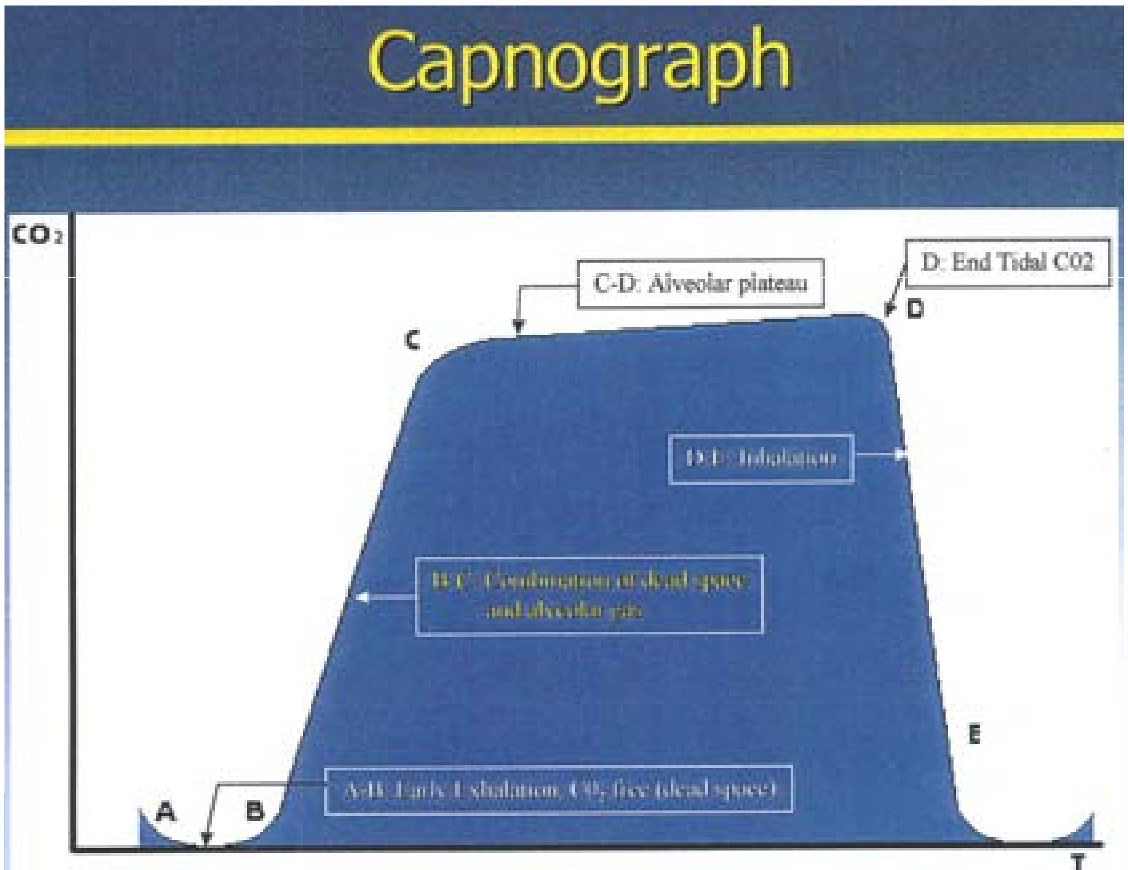


Capnogram: Phase I



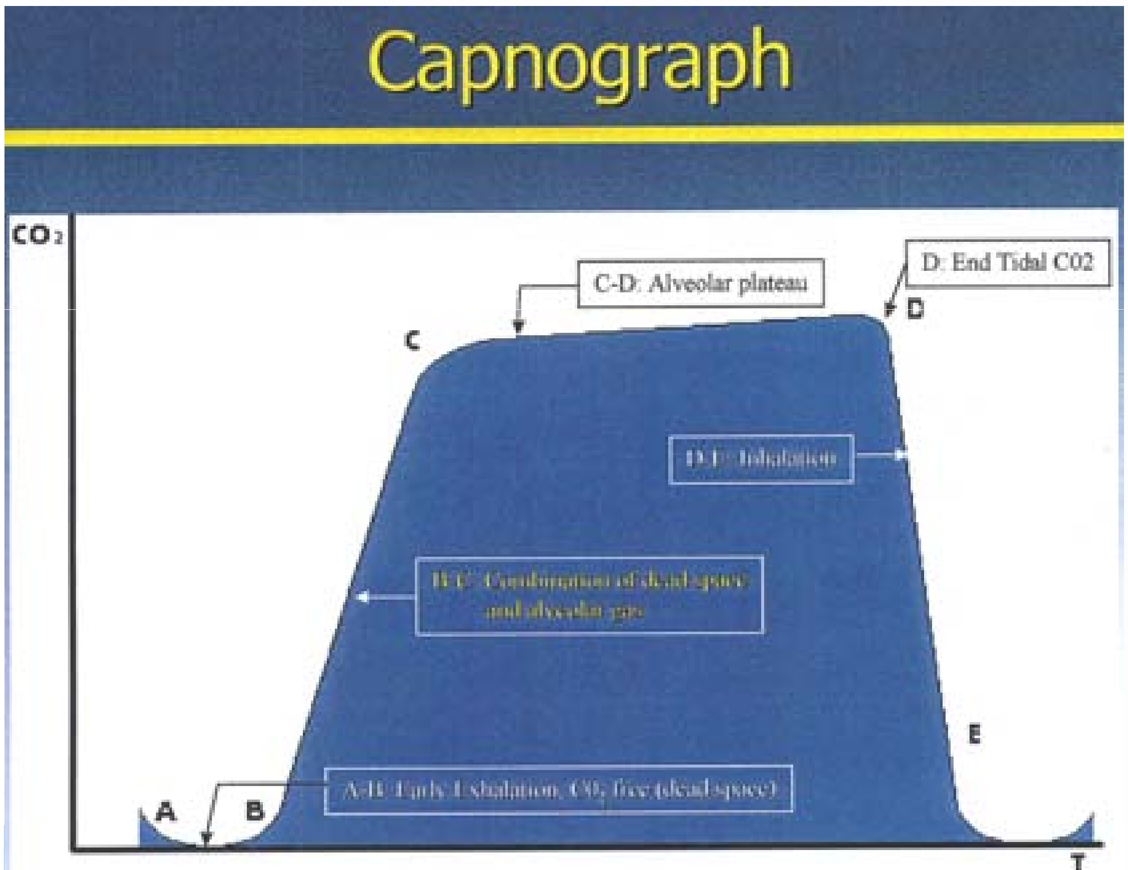
- Phase I occurs during exhalation of air from the anatomic dead space, which normally contains no CO_2.
- This part of the curve is normally flat, providing a steady baseline.

Capnogram: Phase II

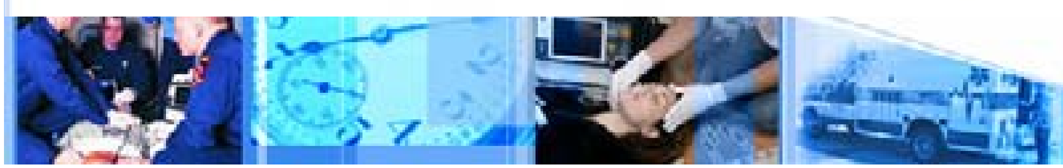


- Phase II occurs during alveolar washout and recruitment, with a mixture of dead space and alveolar air being exhaled.
- Phase II normally consists of a steep upward slope.

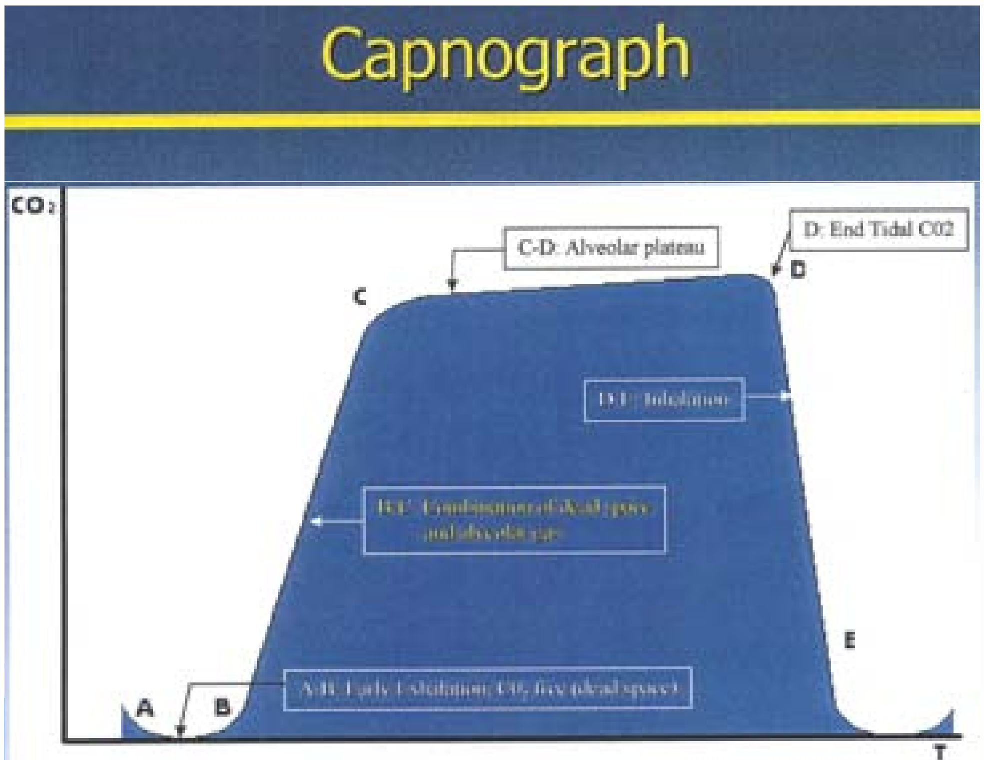
Capnogram: Phase III



- Phase III is the alveolar plateau, with expired gas coming from the alveoli.
- In patients with normal respiratory mechanics, this portion of the curve is flat, with a gentle upward slope.
- The highest point on this slope represents the $EtCO_2$ value.

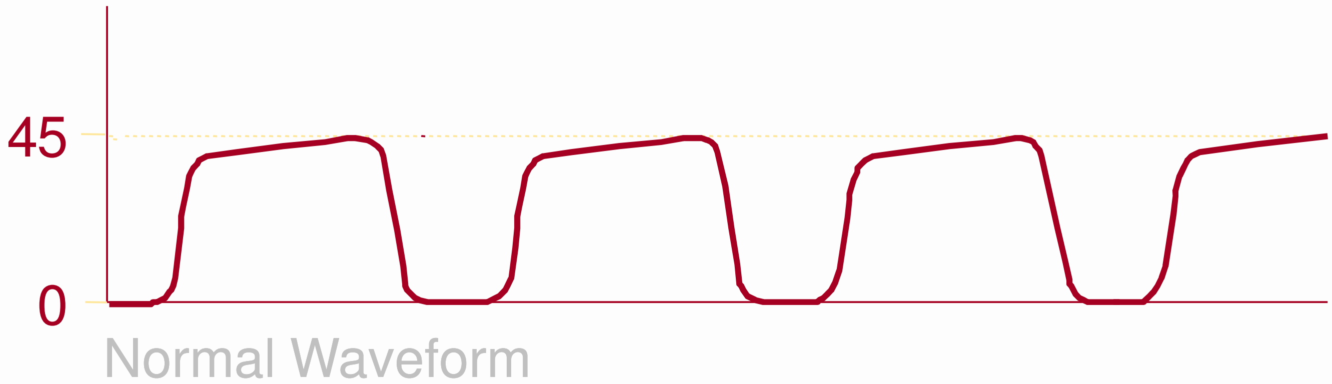


Capnogram: Phase IV



- Atmospheric air contains negligible amounts of CO_2.
- Phase IV occurs during inspiration, where the $EtCO_2$ level normally drops rapidly to zero.
  - Unless CO_2 is present in the inspired air, as occurs when expired air is rebreathed
- This part of the waveform is a steep, downward slope.

Capnography Waveform



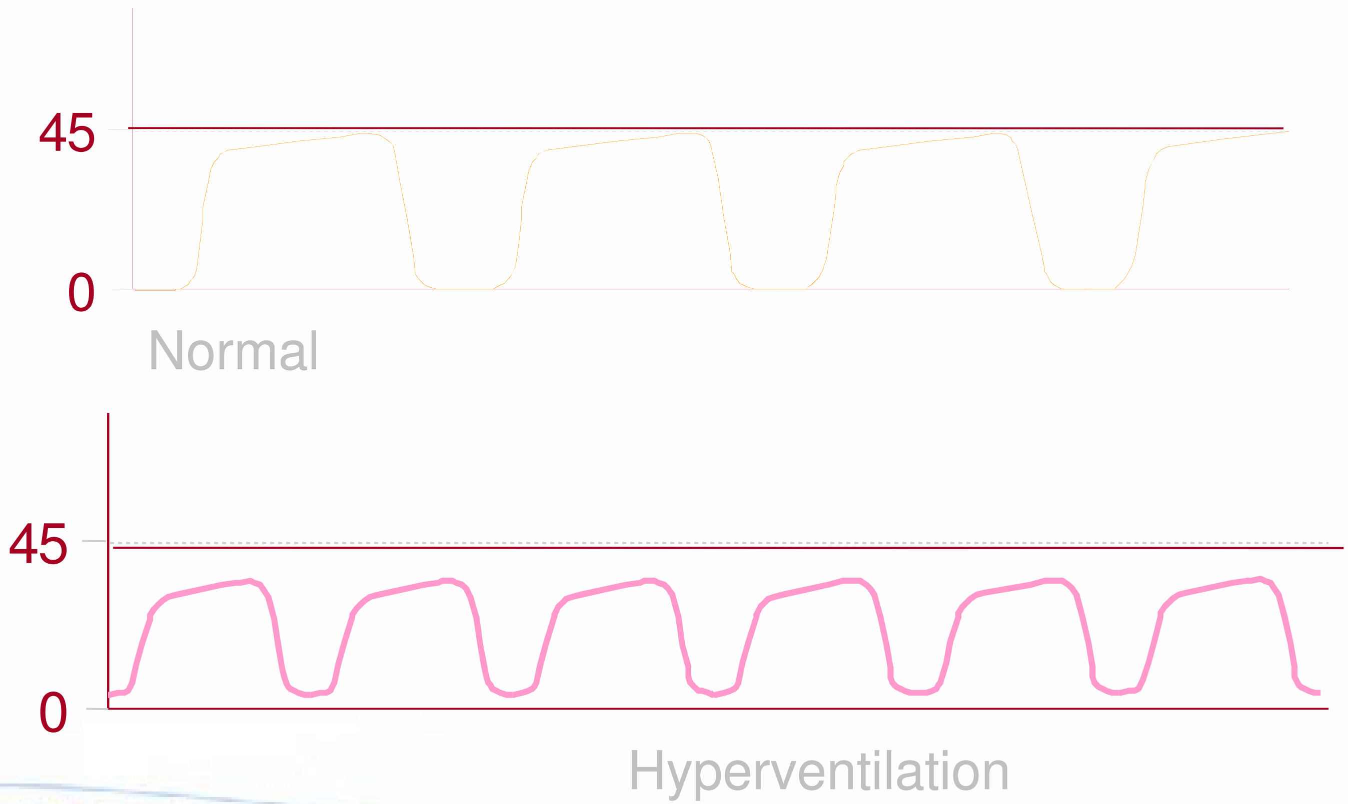
Normal range is 35-45 mm Hg (5% vol)

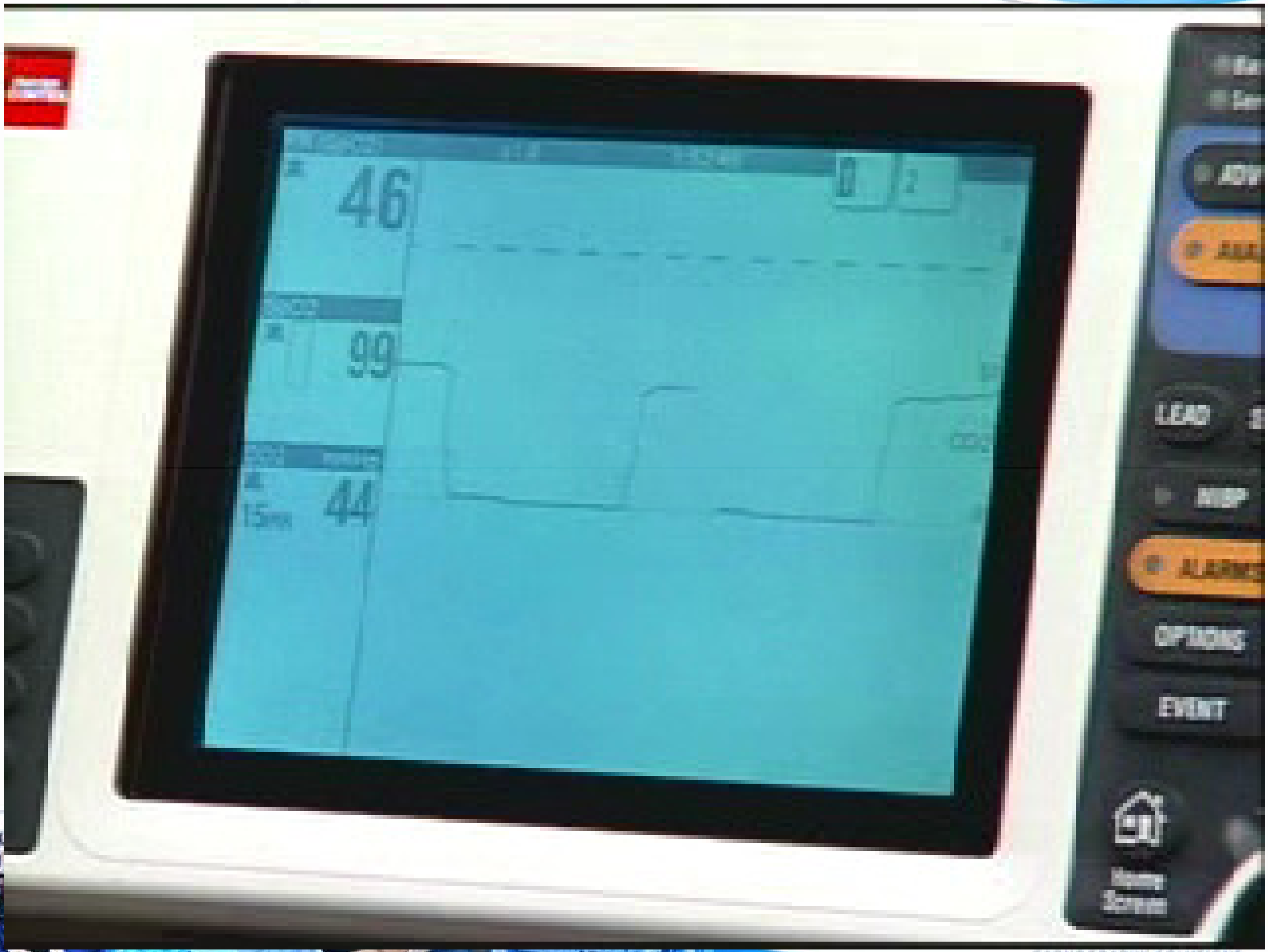
Capnography Waveform Question

- How would your capnogram change if you intentionally started to breathe at a rate of 30?
  - Frequency
  - Duration
  - Height
  - Shape

Hyperventilation

- RR ↑ : $EtCO_2$ ↓




46
99
44
LEAD
OPTIONS
EVENT

Capnography Waveform Question

- How would your capnogram change if you intentionally decreased your respiratory rate decreased to 8?

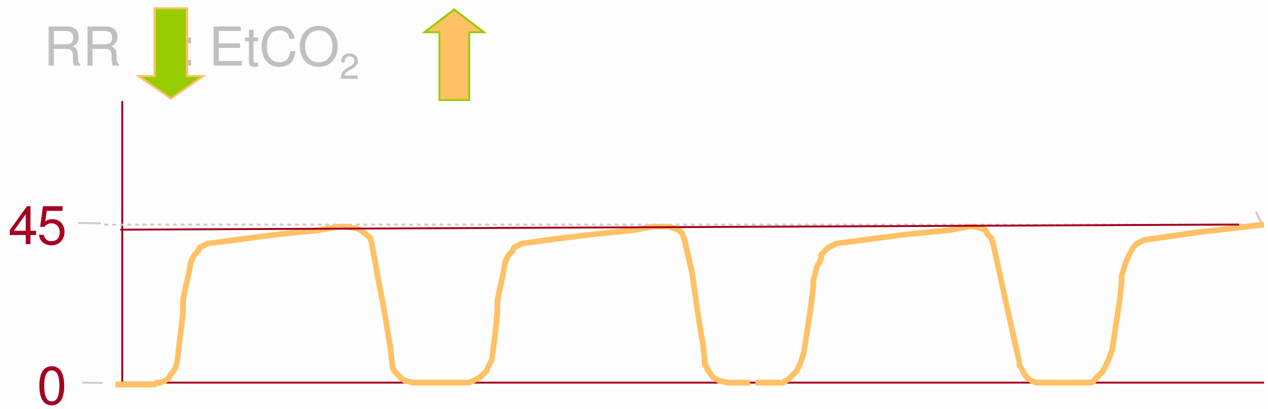
Frequency

Duration

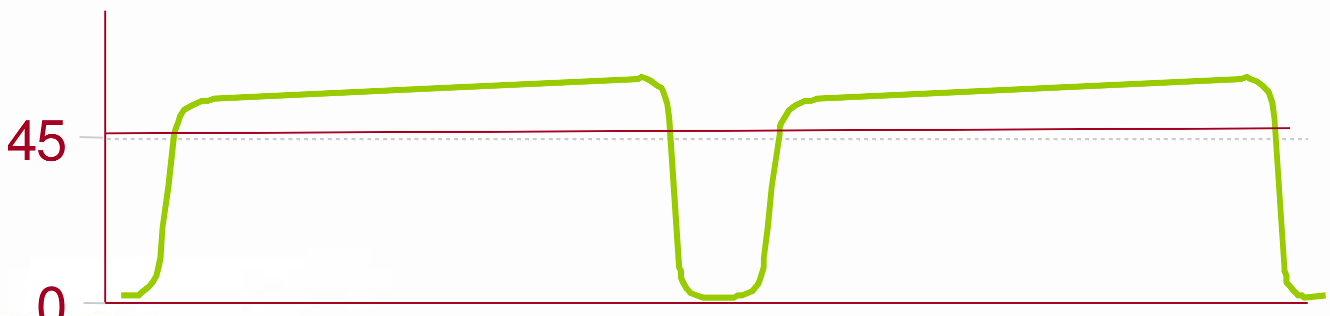
Height

Shape

Hypoventilation



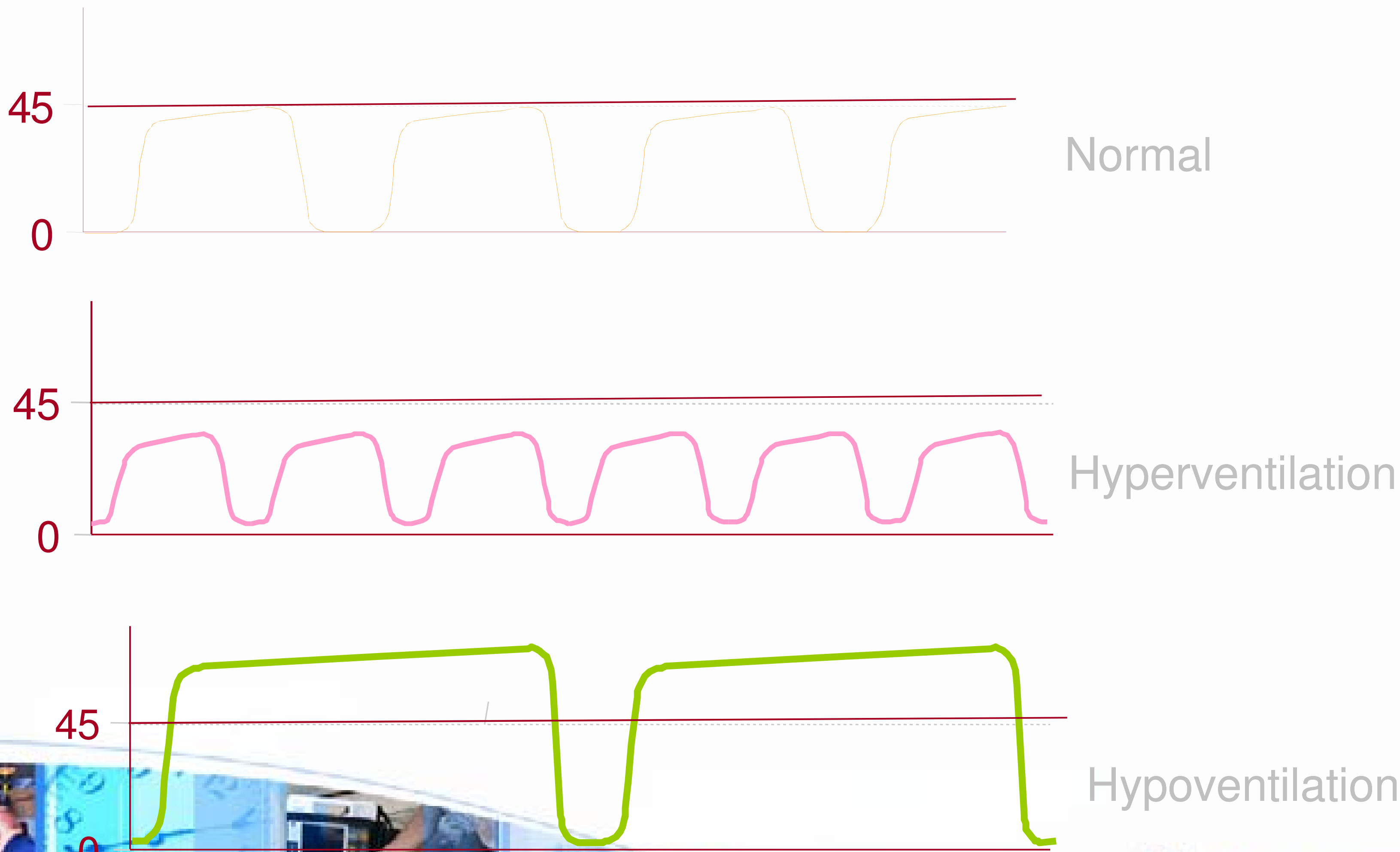
Normal



Hypoventilation

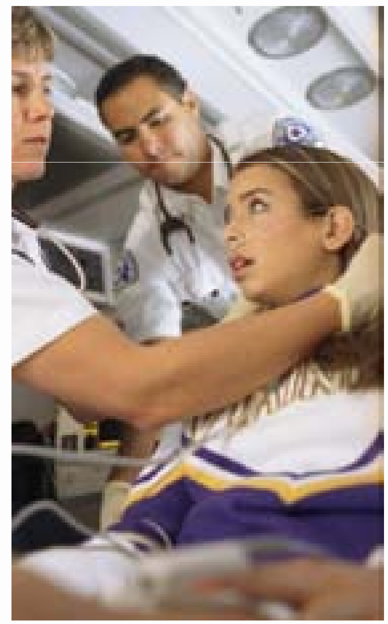

47
100
35
LEAD
NIBP
OPTIONS
EVENT

Capnography Waveform Patterns



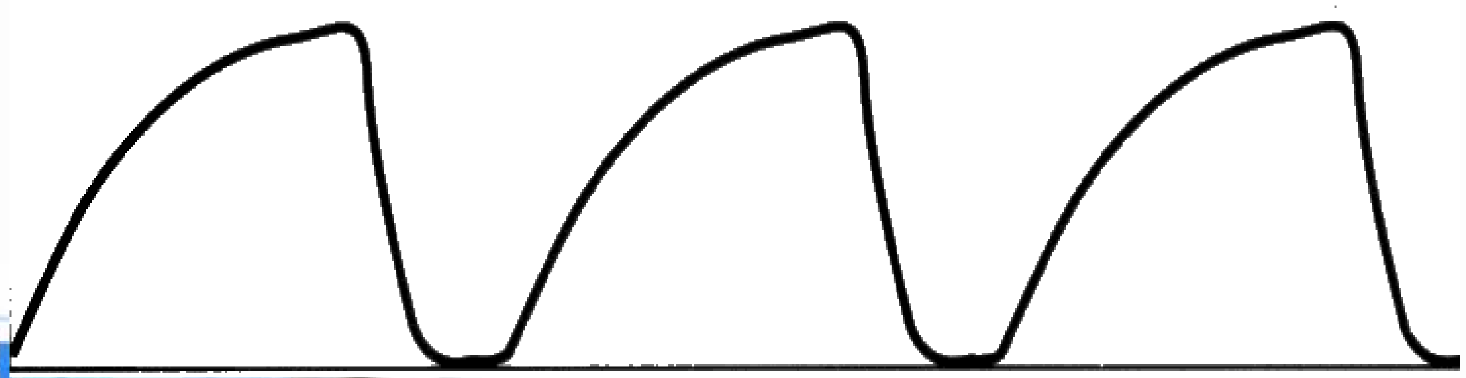
Capnography Waveform Question

How would the waveform shape change during an asthma attack?



Bronchoconstriction

- Shark-like in appearance



Asthma

- Studies are looking at the correlation of baseline values when dealing with asthmatics
- Treatment will then be tailored to what category the patient falls

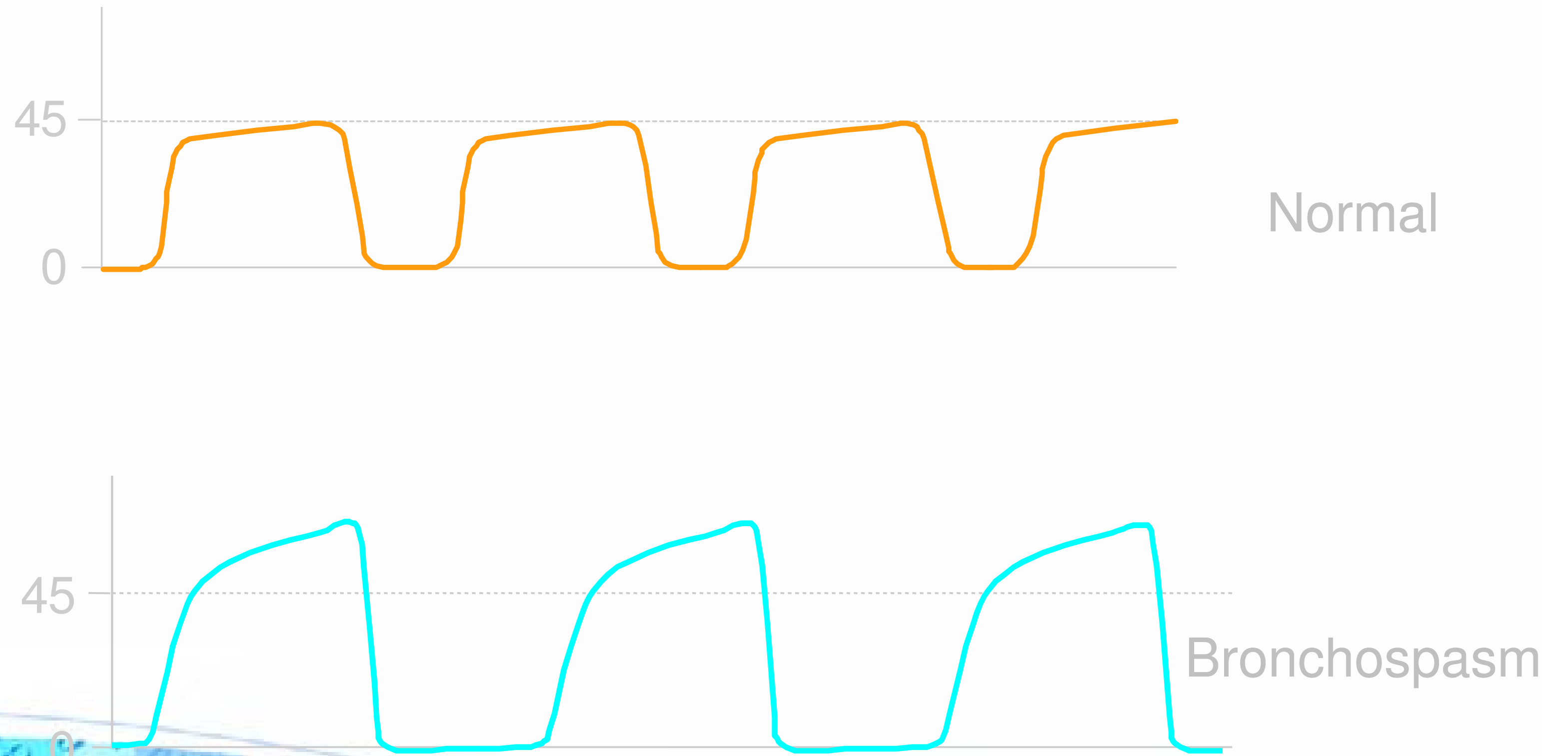
Asthma

- Green—initial distress phase with *decrease* in CO_2 levels. Treatment would include MDI and follow up.
- Yellow—moderate distress phase with *normal* CO_2 levels. Treatment includes neb and transport.
- Red—severe distress phase with *increased* CO_2 levels. This is immediate epi SQ, Neb, and ETT.

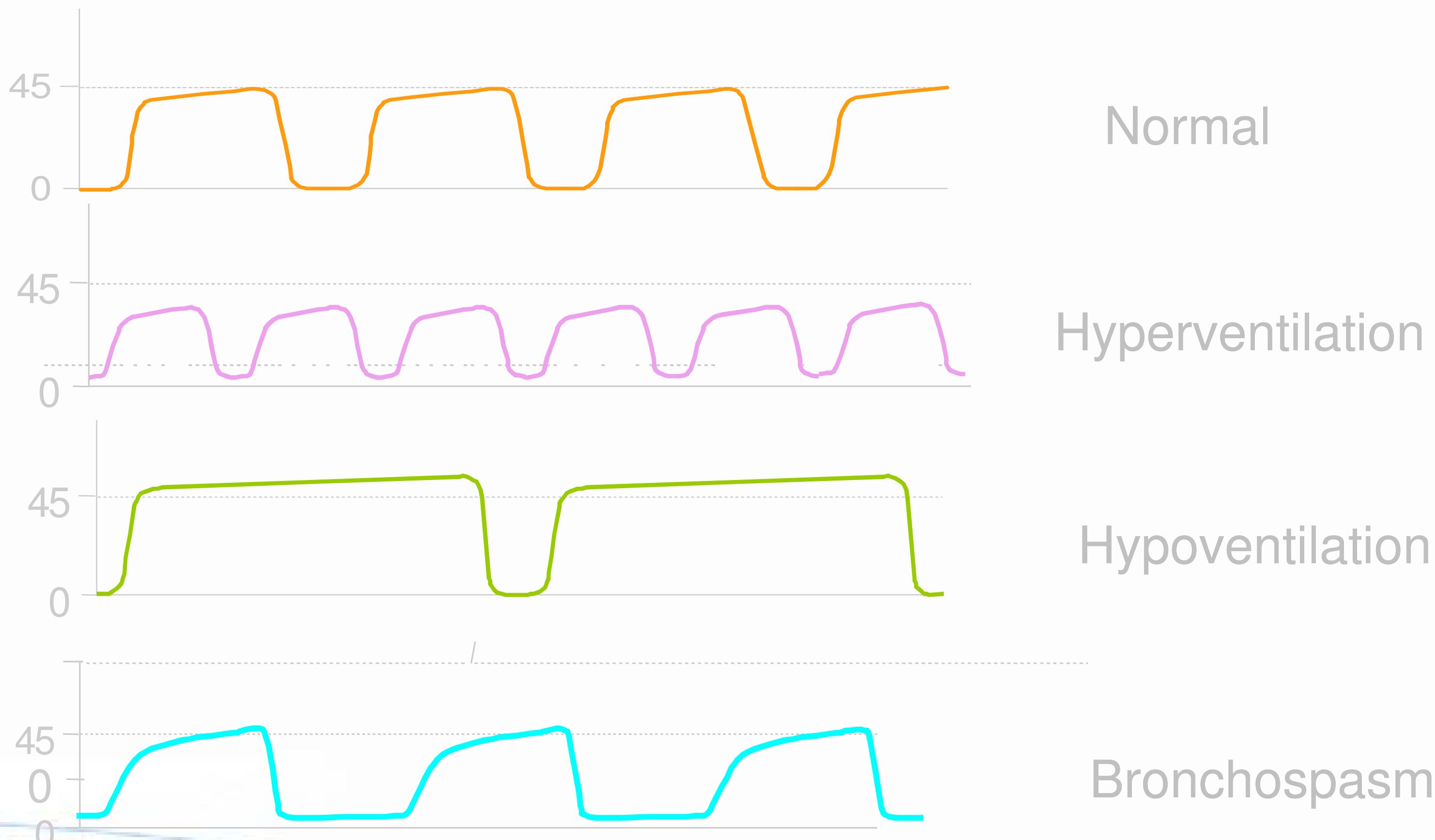
Bronchospasm Waveform Pattern

- Bronchospasm hampers ventilation
  - Curves upstroke of Phase II
- Characteristic pattern for bronchospasm
  - "Shark Fin" shape to waveform.

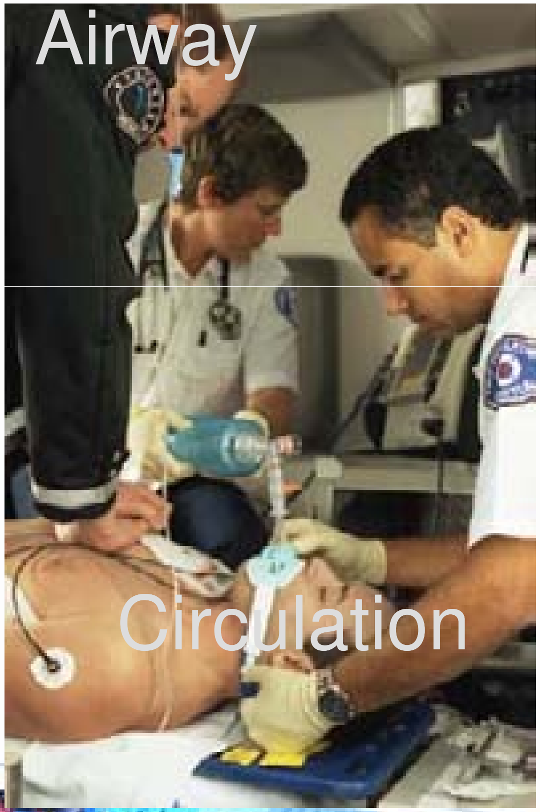
Capnography Waveform Patterns



Capnography Waveform Patterns



Using Capnography



Using Capnography

- Documentation
  - Waveforms
    - Initial assessment
    - Changes with treatment
  - $EtCO_2$ values
    - Trends over time

Capnography Applications on Intubated Patients

- Confirm correct placement of ET tube
- Detect changes in ET tube position *immediately*
- Resuscitation
  - Assess adequacy of chest compressions
  - Detect ROSC
  - Objective data for decision to cease resuscitation
- Optimize ventilation of patients
- Document, document, document

Confirm ET Tube Placement

- Traditional methods of confirmation
  - Listen for breath sounds
  - Observe chest movement
  - Auscultate stomach
  - Note ET tube clouding

These methods are subjectiv
and can be unreliable

Confirm ET Tube Placement

- "The presence of exhaled CO_2 indicates proper tracheal tube placement." P I-101
- "…end-tidal CO_2 monitors can confirm successful tracheal tube placement within seconds of an intubation attempt" P I-101

Source: Guidelines 2000 for Cardiovascular Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2000;102(suppl I)8. August 22,2000

Microstream CAPNOGRAPHY SOLUTIONS

Confirm ET Tube Placement

- 108 patients intubated in the Field
  - 52 trauma patients
  - 56 medical patients
- ET tube placement checked on arrival at the ED
- 27 patients (25%) had improperly placed ET tube
  - 18 were in the esophagus
  - 9 in oropharynx with tip above the cords

Source: Falk J, Sayre MR. “Confirmation of Airway Placement” , *Prehospital Emergency Care. 1999 ; 3:273-278*

Confirm ET Tube Placement

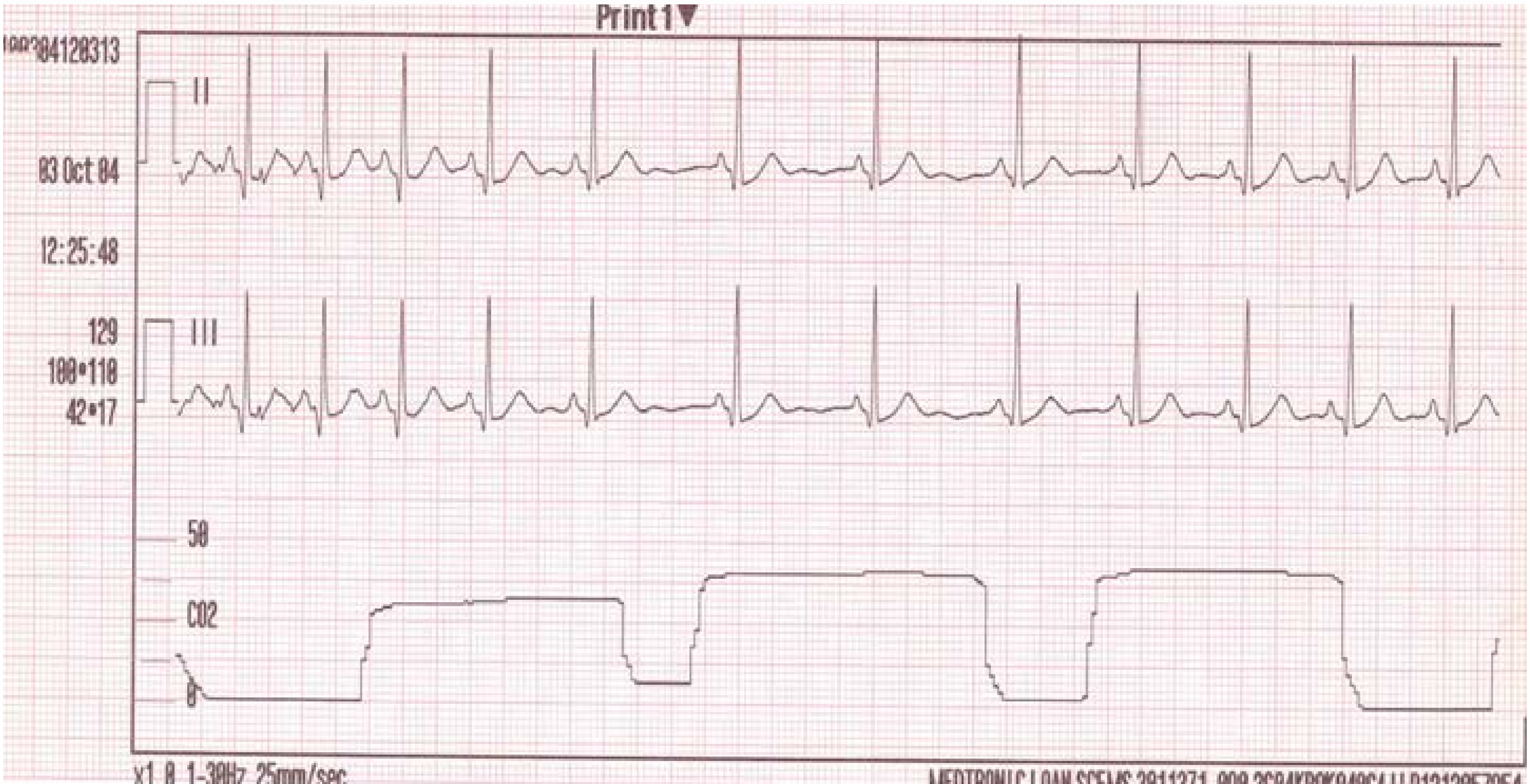
" All endotracheal intubations must be accompanied by an objective confirmation…The optimal method of measurement is quantitative capnography and its use on all intubated patients." p-277

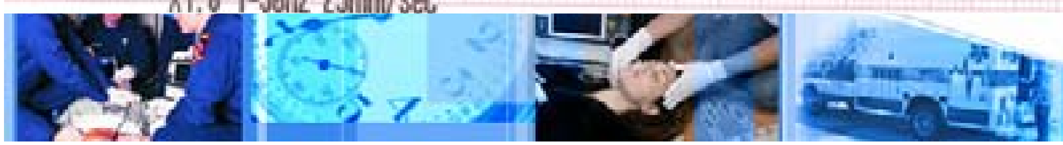
Source: Falk J, Sayre MR. "Confirmation of Airway Placement" , *Prehospital Emergency Care. 1999 ; 3:273-278*

Confirm ET Tube Placement

- Capnography provides
  - Documentation of correct placement
  - Ongoing documentation over time through the trending printout
  - Documentation of correct position at ED arrival

Transferred to ED at 12:25





Confirm ET Tube Placement

- Study in neonates
  - 100 intubations
  - 40 were esophageal
  - Capnography identified 39 of the 40
  - Mean time to detection of esophageal intubation
    - 1.6 seconds with capnography
    - 97 seconds with clinical signs.

Source: Roberts W, et al. 1995.Pediatric Pulmonology. 19:262-268

Airway – Rescue Devices

Combitube

LMA

Confirm ET Tube Placement

- ET tube placement in esophagus may briefly detect CO_2
  - Following carbonated beverage ingestion
  - When gastric distention was produced by mouth to mouth ventilation
- CO_2 detection will disappear after 6 positive pressure breaths

Detect ET Tube Displacement

- Traditional methods of monitoring tube position
  - Periodic auscultation of breath sounds
  - Gastric distention
  - Worsening of patient’s color
    - Late sign of tube displacement

These methods are subjective and unreliable

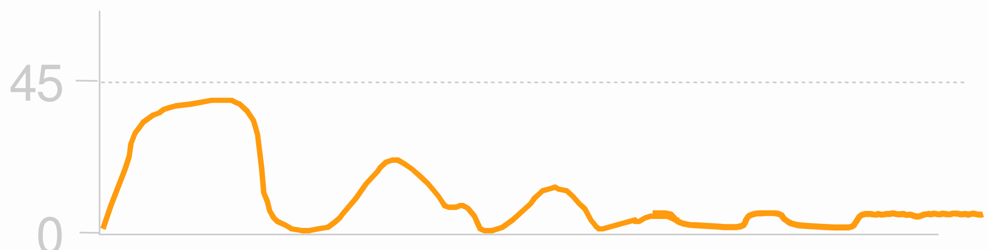
Detect ET Tube Displacement

- " Continuous capnography monitoring devices can identify and signal a fall in exhaled CO2 consistent with tracheal tube dislodgement. This may be very helpful in emergencies when clinicians have other responsibilities." p-140

Source: ACLS-The Reference Textbook, ACLS: Principles and Practice. Ed. RO Cummins. American Heart Association. 2003. ISBN 0-87493-341-2

Detect ET Tube Displacement

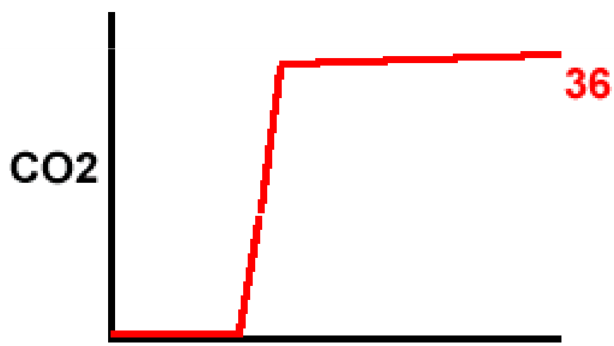
- Capnography
  - *immediately* detects ET tube displacement

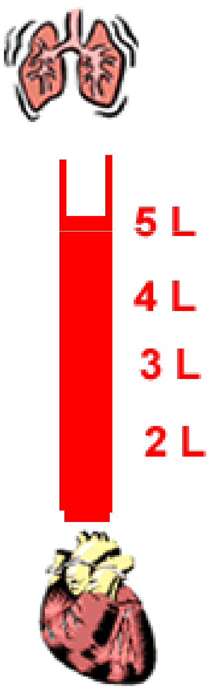


Capnography in Cardio Pulmonary Resuscitation

- Assess chest compressions
- Early detection of ROSC
- Objective data for decision to cease resuscitation

CPR, Cardiac Output, and EtCO2





Reference: Capnography.com

CPR: Assess Chest Compressions

- Capnography provides non-invasive method for monitoring blood flow generated by CPR
- Airway- open with ET tube
- Breathing - controlled and stable
- Circulation- cardiac output directly related to changes in $EtCO_2$

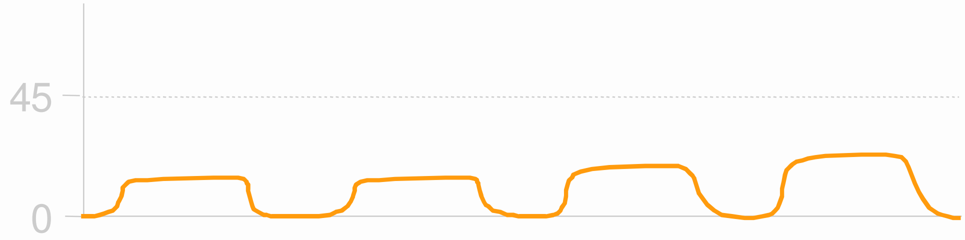
CPR: Assess Chest Compressions

- Increase in $EtCO_2$ has been shown to correlate with
  - A fresh rescuer at a faster compression rate
  - A new rescuer during CPR with no change in rate
  - Mechanical compressions

Better compressions lead to higher ETCO2 levels

Source: White RD. “Out-of-Hospital Monitoring of End-Tidal Carbon Dioxide Pressure During CPR” , *Annals of Emergency Medicine. 1994; 23(1):756-761*

CPR: Assess Chest Compressions



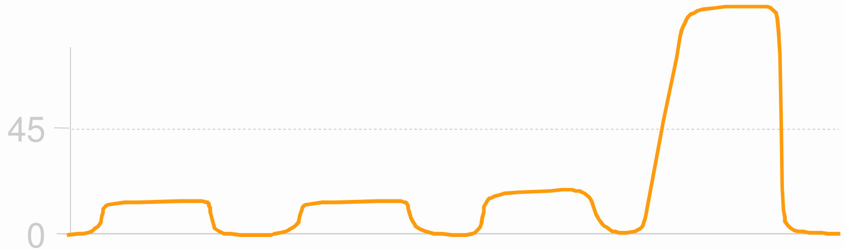
Use feedback from ETCO2 to depth/rate/force of chest compressions during CPR

CPR: Detect ROSC

- 90 prehospital patients intubated in the field
- 16 survivors
- In 13 survivors a rapid rise on CO_2 production was the earliest indicator of ROSC.
  - Before a palpable pulse
  - Prior to blood pressure

Source: Wayne MA "Use of End-tidal Carbon Dioxide to Predict Outcome in Prehospital Cardiac Arrest" . *Annals of Emergency Medicine. 1995; 25(6):762-767*

CPR: Detect ROSC



ETCO2 DURING CPR

Onset of arrest → ETCO2 decreases

During CPR → ETCO2 increases slightly

ROSC → ETCO2 markedly increases

ROSC(cont'd) → ETCO2 falls slightly

Dependent on down time and preexisting conditions

Decision to Cease Resuscitation

- Capnography
  - Has been shown to predict probability of outcome following resuscitation
  - May be used in the decision to cease resuscitation efforts

Source: Levine RL. End-tidal carbon dioxide and outcome of out-of-hospital cardiac arrest. *New England Journal of Medicine.* 1997;337(5):301-306.

Decision to Cease Resuscitation

- 90 victims of prehospital cardiac arrest with PEA
- EtCO2 in ROSC was much higher after 20 minutes

	ROSC	No ROSC	
Initial	10.9±4.9	11.7±6.6	*P=.672 (NS)*
20 min	31.0±5.3	3.9±2.8	*P<=.0001*

- 100% mortality if unable to achieve an $EtCO_2$ of 10 mm Hg after 20 minutes

Source: Wayne MA. Use of End-tidal Carbon Dioxide to Predict Outcome in Prehospital Cardiac Arrest. *Annals of Emergency Medicine.* 1995;25(6):762-767

Optimize Ventilation

- Use capnography to titrate $EtCO_2$ levels in patients sensitive to fluctuations
- Patients with suspected intracranial pressure (ICP)
  - Head trauma
  - Stroke
  - Brain tumors
  - Brain infections

Optimize Ventilation

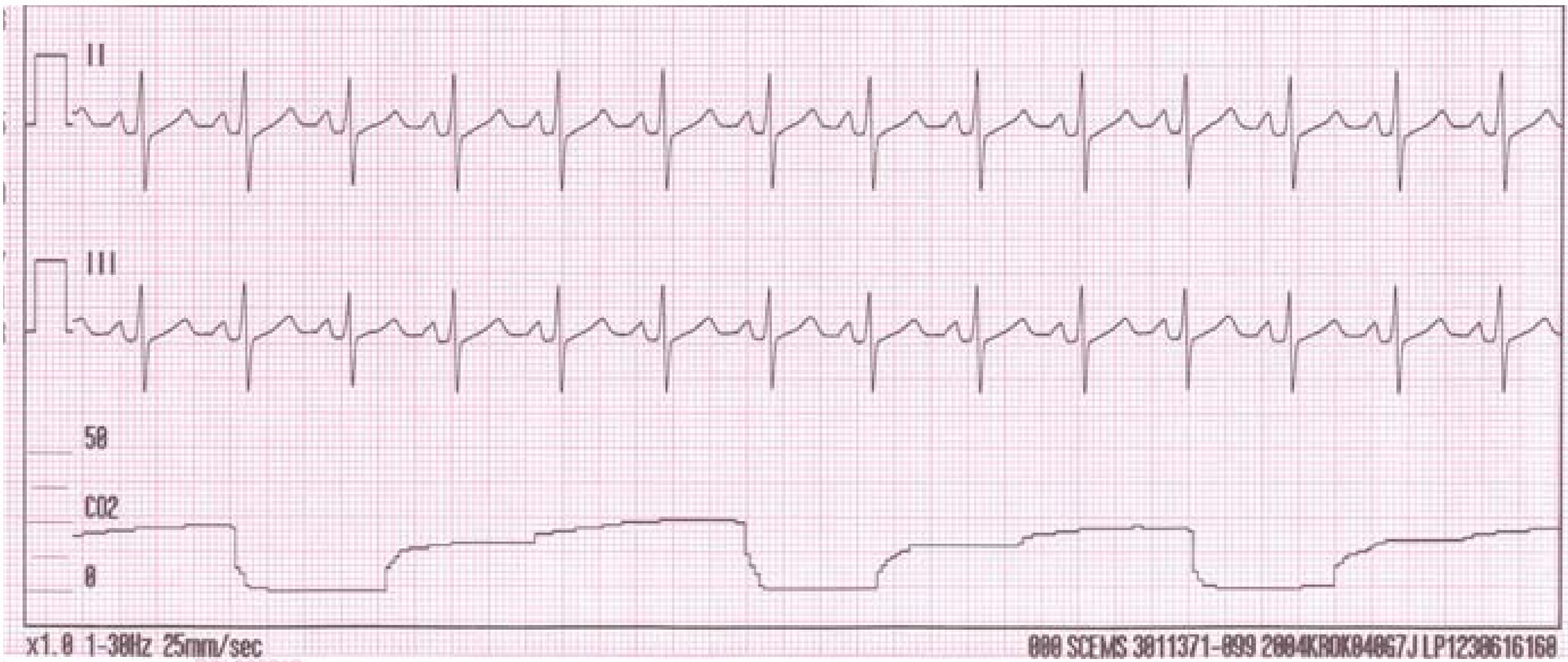
- Monitor ventilations with capnography to maintain appropriate and stable CO_2 levels
- Follow local protocols and medical direction

Non-Intubated Patients

- Objective Assessment of Respiratory Complaints
  - Asthma
  - COPD vs. CHF
- Response to Treatment of Pain
- Assessment of Airway & Ventilatory Status
  - Seizure
  - Intoxication
  - Overdose
- Perfusion Assessment
  - Pacing (Electrical vs. Mechanical Capture)
  - Stable vs. Unstable tachycardia's
  - PEA vs. rhythm with low perfusion

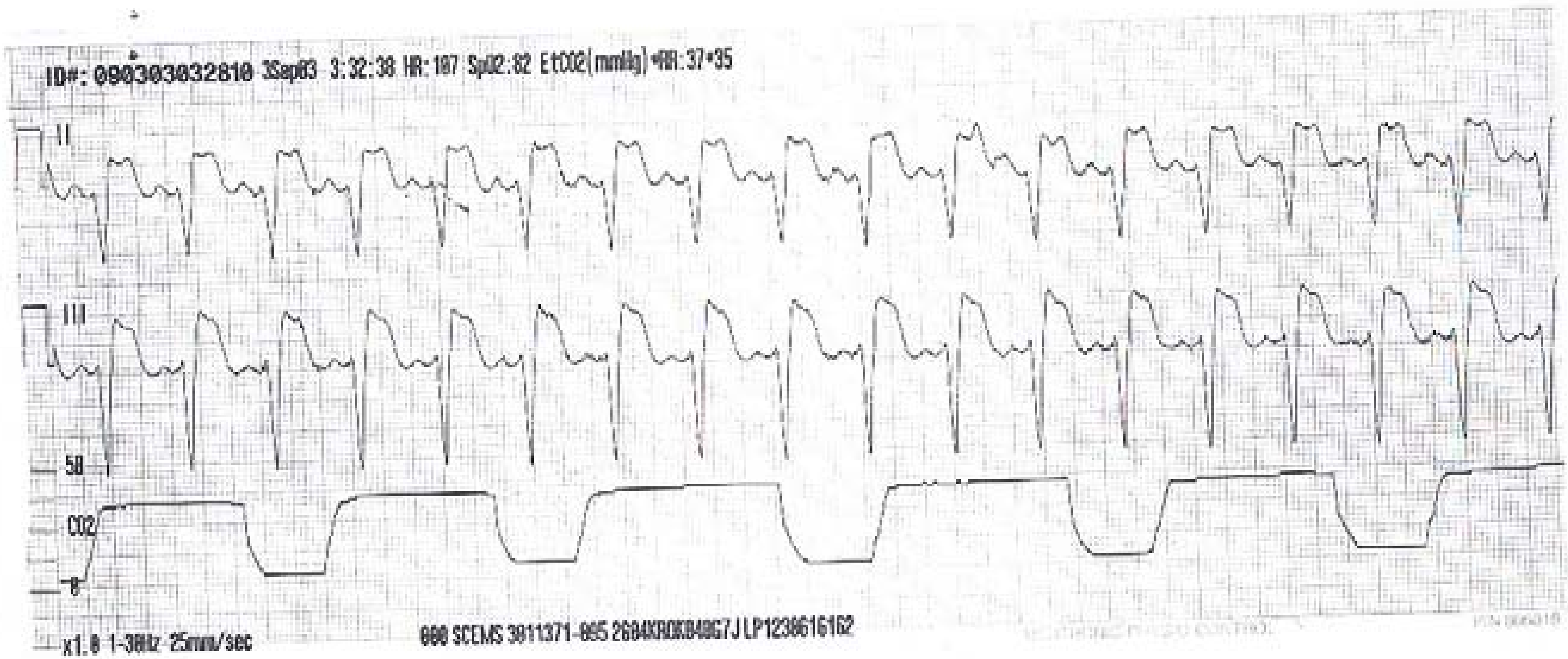
Case Presentations

78 y/o Male, short of breath Hx. Of CHF and COPD



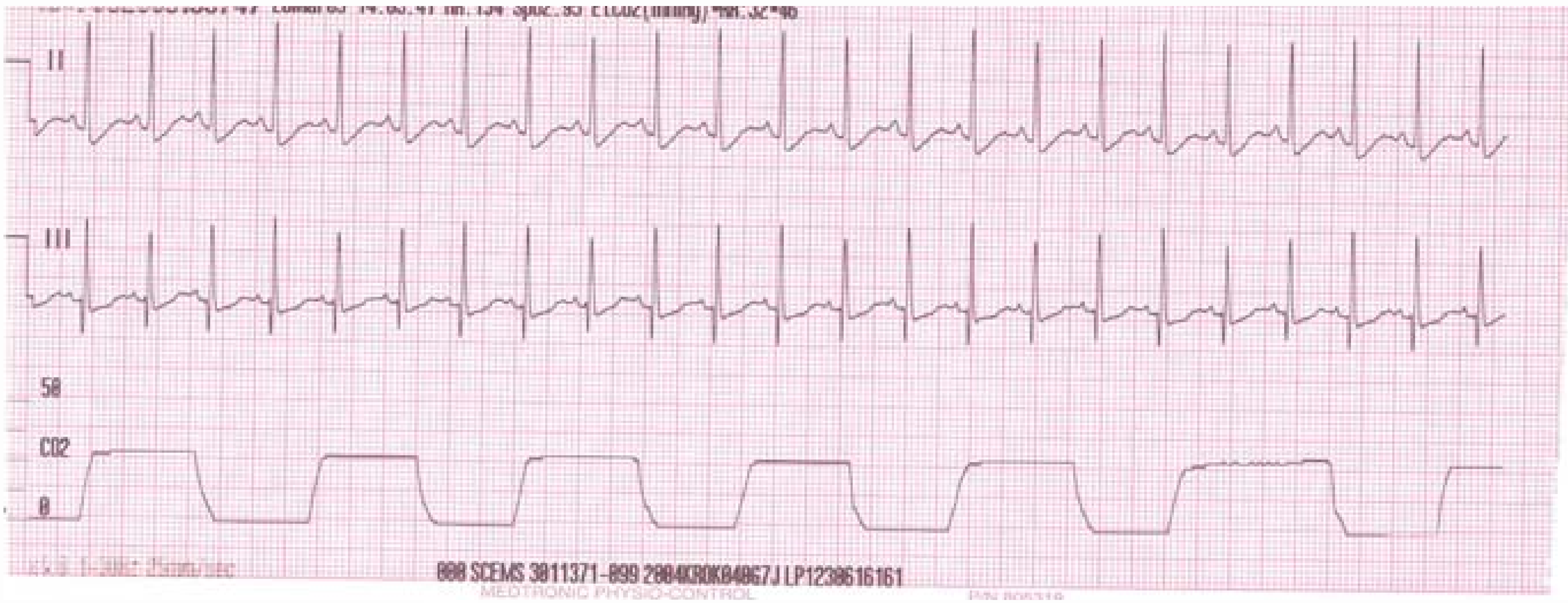
Patient treated with Albuterol, Solu-Medrol and Magnesium Sulfate.

66 y/o female, hx of COPD and CHF, acute onset of CP and Shortness of Breath



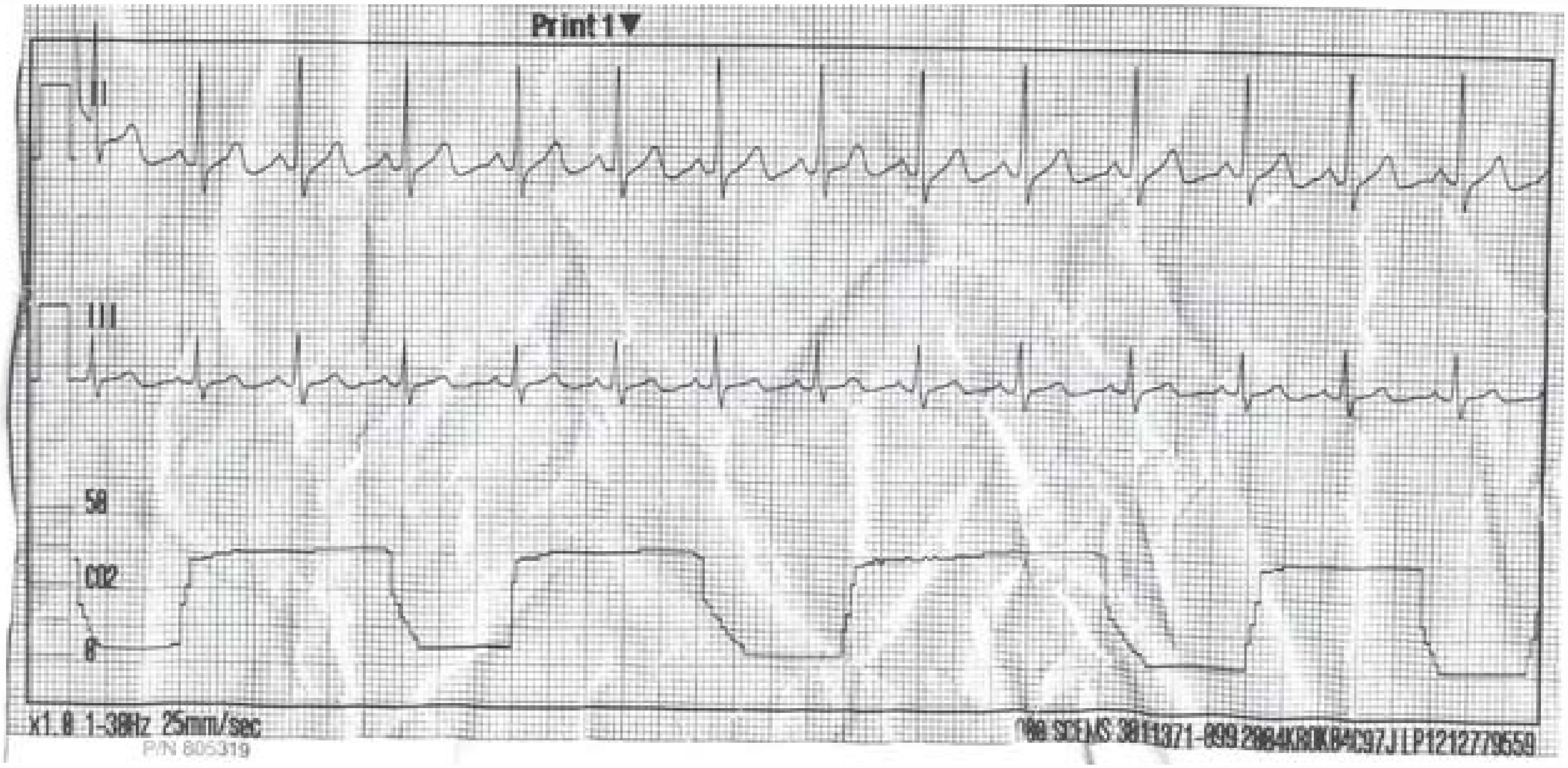
Patient placed on CPAP, treated with NTG, Lasix and Morphine. (Above strip was with CPAP in place)

4 y/o female, sister has Asthma and mom administrated her sister's MDI. RR 46, PR 146



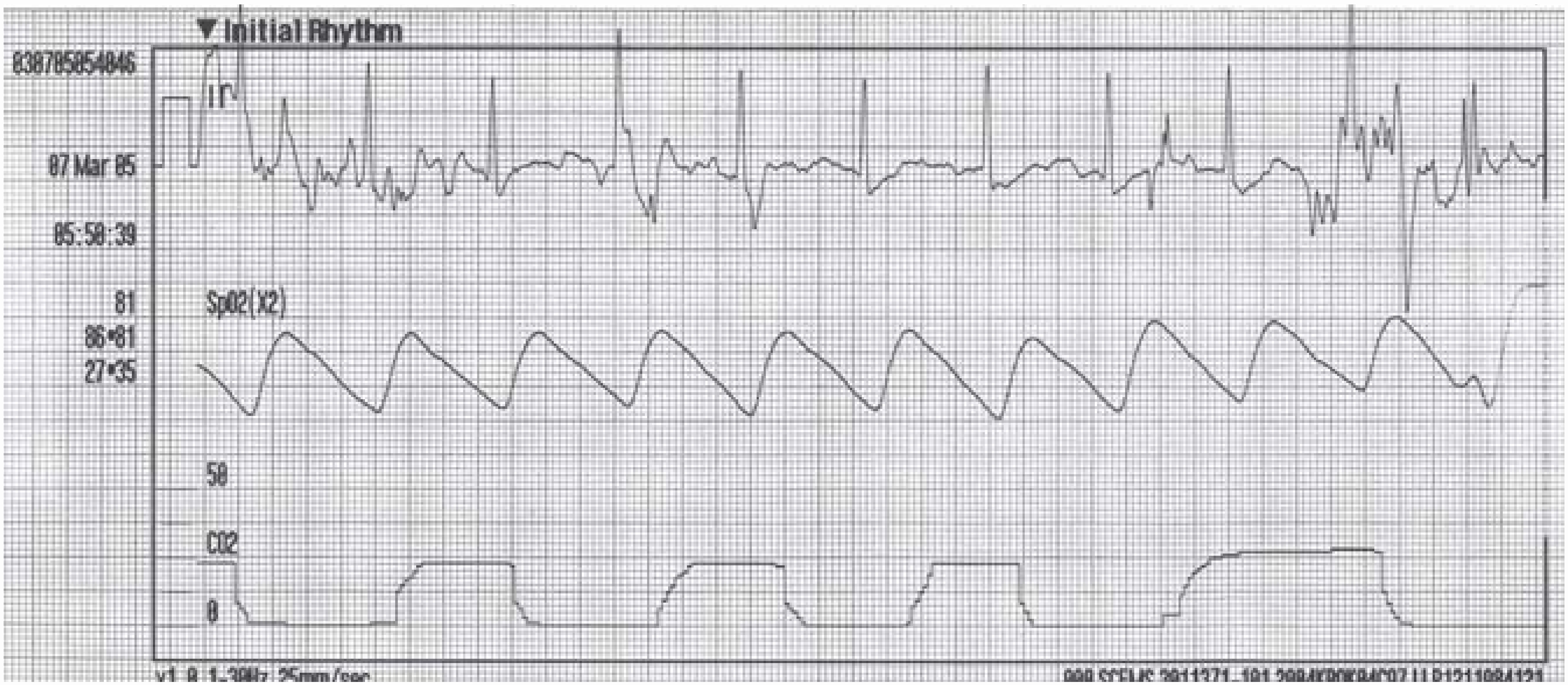
Is there Bronchoconstriction present?

10 y/o female hx of Asthma, School nurse treated with 2 neb. treatments.



Is there Bronchoconstriction present?

89 y/o male called 911 for his wife who fell, he c/o dyspnea. Hx of COPD.

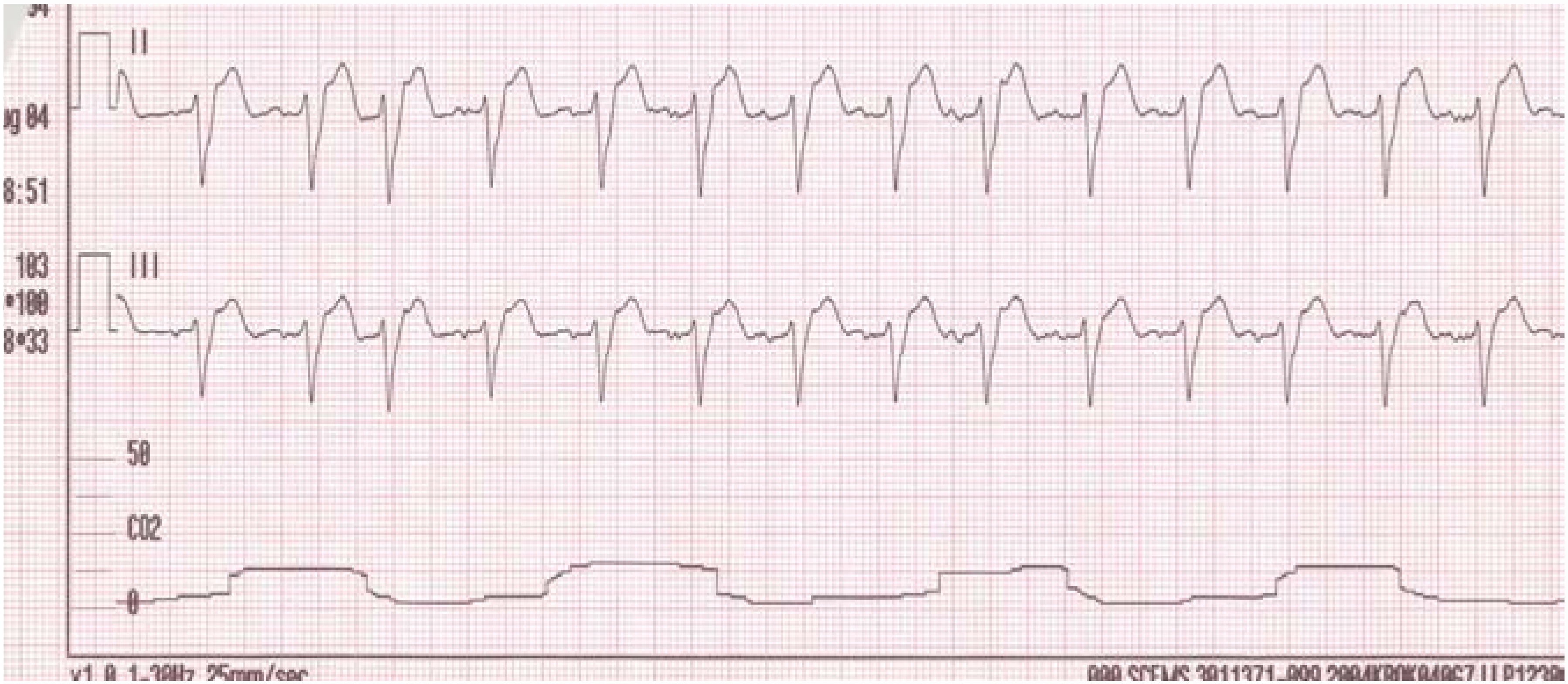


Is there Bronchoconstriction present?

2 year old with special needs having a seizure

Does the patient have an airway and is she ventilating adequately?

60 y/o CPR in progress, rhythm change noted



No palpable pulses, how can we determine if there is perfusion?

CPR is stopped, Ventilations are continued.

Is there perfusion? Why or Why Not

When every breath counts

48 y/o male Narcotic OD. Code Summary

	Time	Event	HR	Sp02•PR	EtC02(mmHg)•RR	NIBP(mmHg)•PR
001905141705	14:17:05					
	14:18:22			---•---		
	14:18:58		57	97•59		
Sex:	14:22:03		59	---•---		
	14:22:32		59	---•---		
	14:27:03		57	---•---		
Aug 05 14:17:05	14:27:05		57	---•---		
000	14:29:13		64	98•63		142/97(111)•63
SCEMS	14:32:04		60	99•60		
00:41:56	14:36:51		52	99•59		
	14:37:04		64	99•62		
	14:42:03		76	100•73		
	14:45:16		63	99•63		137/90(100)•63
	14:47:04		68	98•68		
	14:47:46		66	98•67		
	14:52:03		---	---•---		
	14:57:03		---	---•---		
	14:59:01					

Are there any issues present?

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48 y/o male Narcotic OD. Code Summary

081905141705

Sex:

Aug 05 14:17:05

000

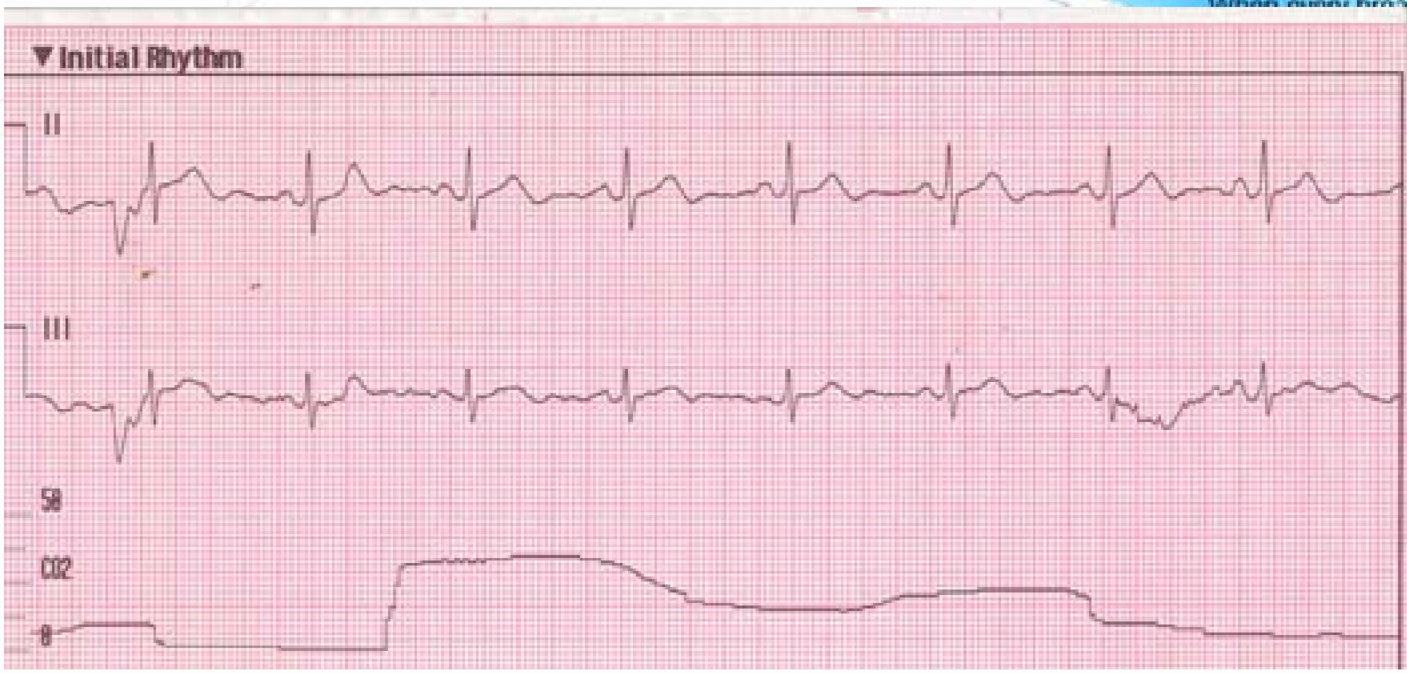
SCEMS

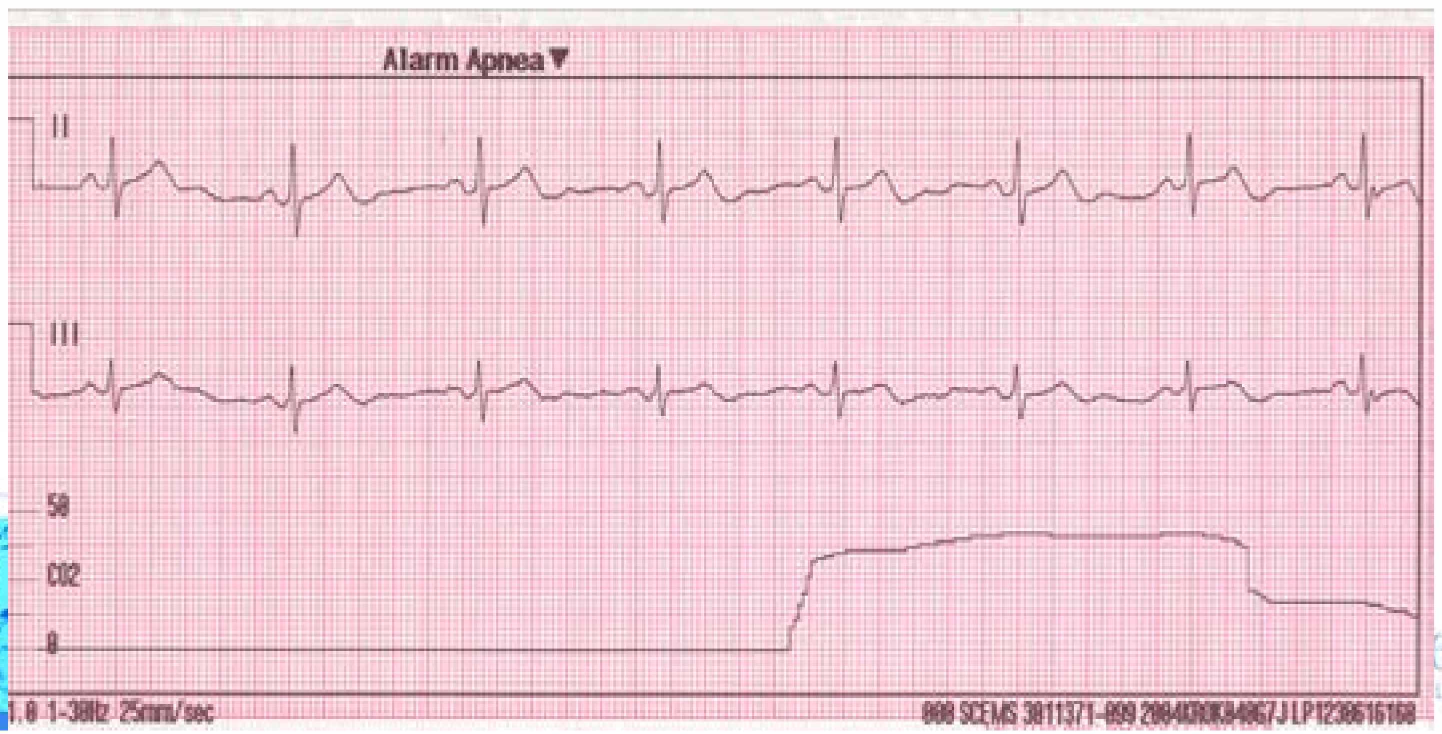
00:41:56

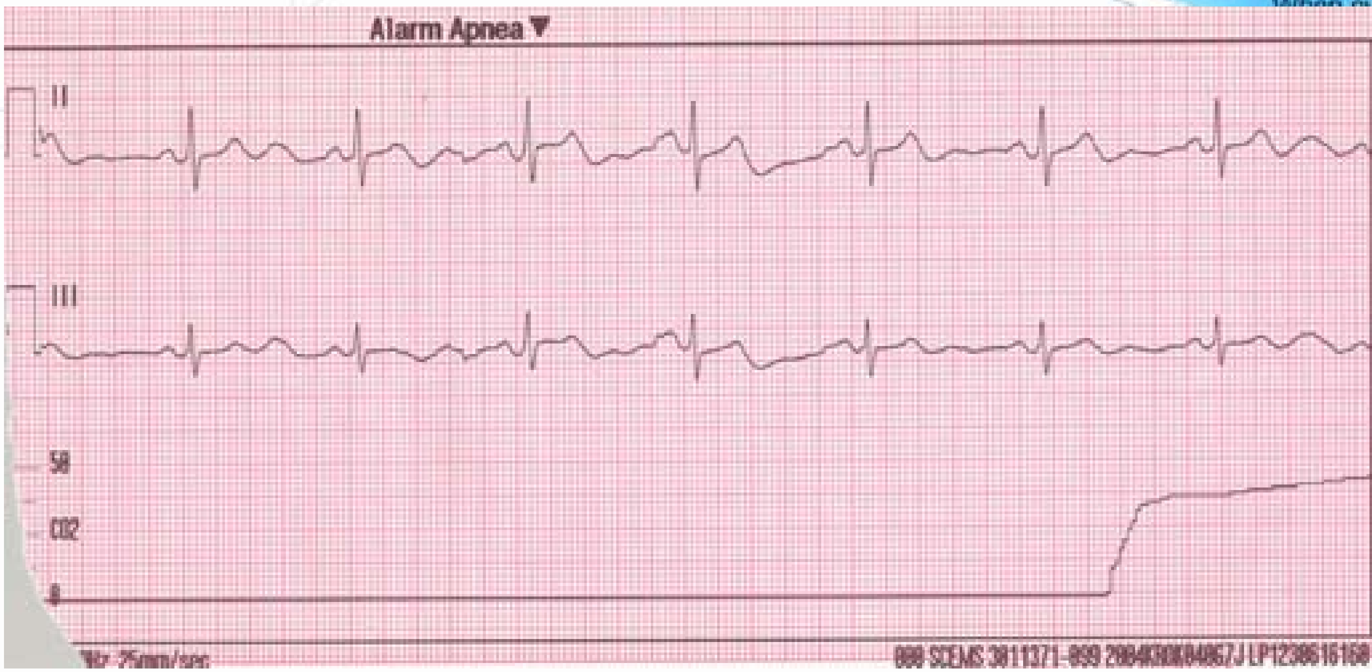
Time	Event	HR	SpO2•PR	EtCO2(mmHg)•RR	NIBP(mmHg)•PR
14:17:05	Power On				
14:18:22	Initial Rhythm		---•---	36•6	
14:18:58	Alarm Apnea	57	97•59	21•9	
14:22:03	Vital Signs	59	---•---	35•6	
14:22:32	Alarm Apnea	59	---•---	---•---	
14:27:03	Vital Signs	57	---•---	20•14	
14:27:05	Alarm Apnea	57	---•---	20•14	
14:29:13	NIBP	64	98•63	50•9	142/97(111)•63
14:32:04	Vital Signs	60	99•60	47•7	
14:36:51	Alarm Apnea	52	99•59	39•12	
14:37:04	Vital Signs	64	99•62	45•8	
14:42:03	Vital Signs	76	100•73	39•21	
14:45:16	NIBP	63	99•63	37•16	137/90(108)•63
14:47:04	Vital Signs	68	98•68	38•20	
14:47:46	Generic	66	98•67	36•19	
14:52:03	Vital Signs	---	---•---	---•---	
14:57:03	Vital Signs	---	---•---	---•---	
14:59:01	Power Off				

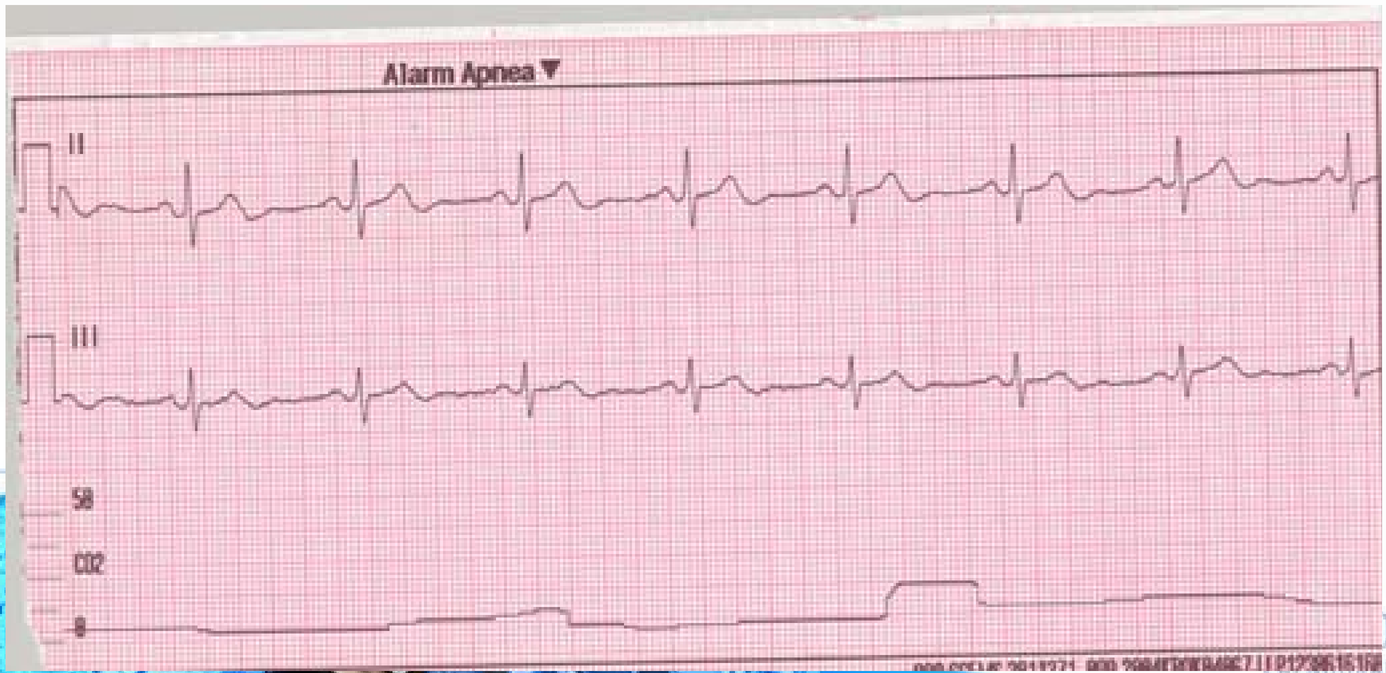
Are there any issues present?

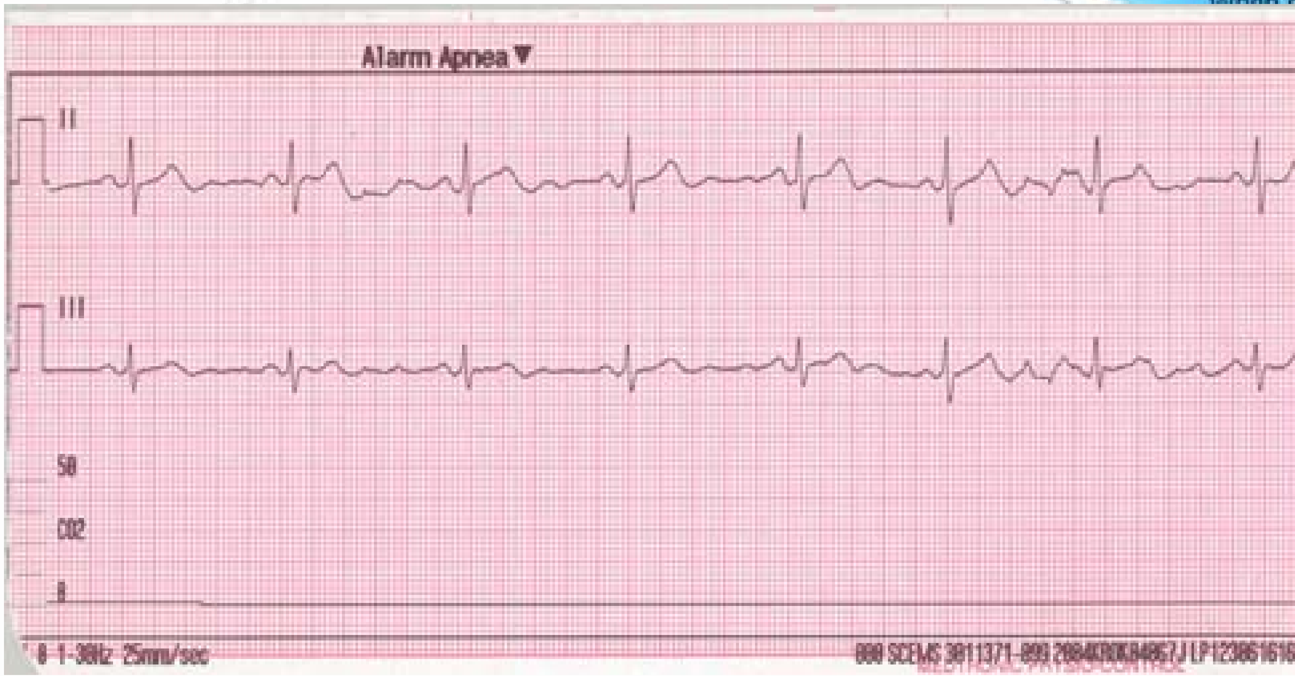
Microstream CAPNOGRAPHY SOLUTIONS

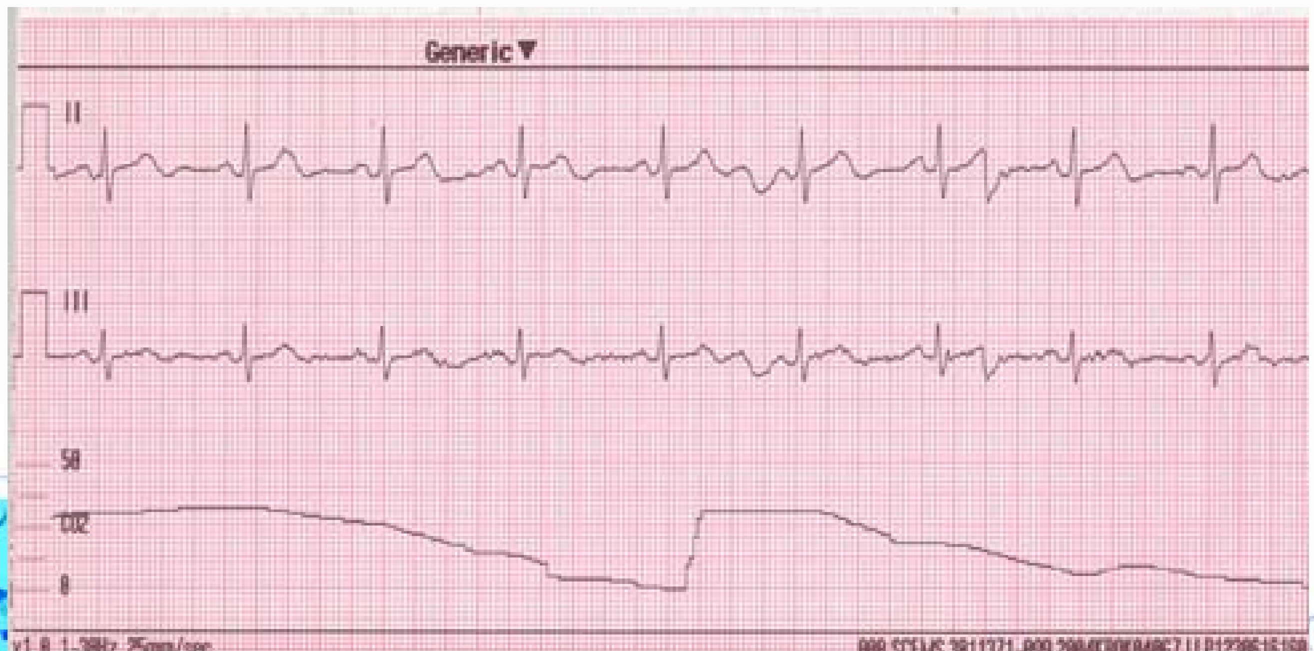

▼ Initial Rhythm
II
III
50
CO2
0


Alarm Apnea ▼
II
III
50
CO2
0
1.0 1-30Hz 25mm/sec

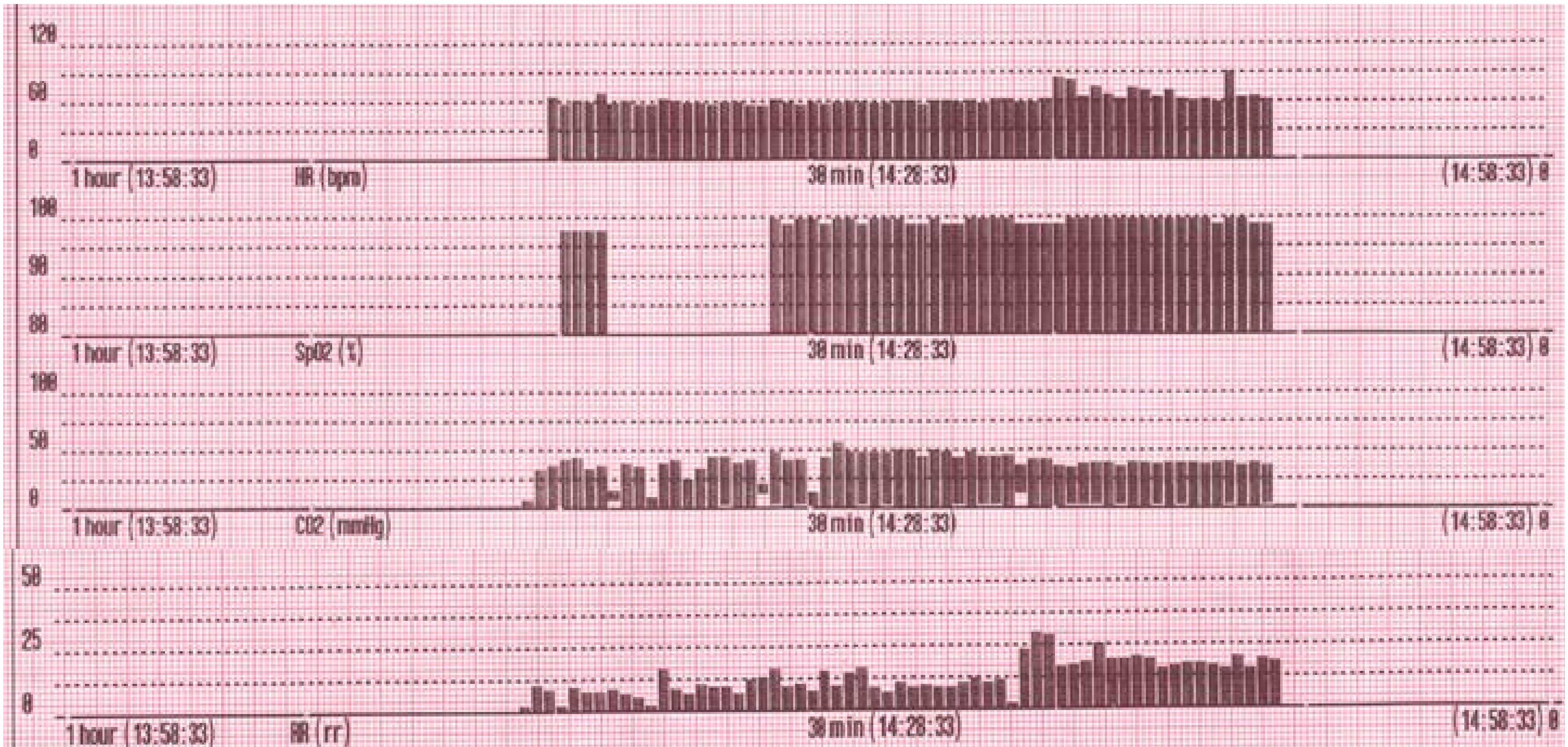

Alarm Apnea ▼
II
III
50
CO2
0


Alarm Apnea ▼
II
III
50
CO2
0


Alarm Apnea ▼
II
III
50
CO2
0
1-30Hz 25mm/sec


Generic ▼
II
III
50
CO2
0
x1.0 1-30Hz 25mm/sec

Trend Summary



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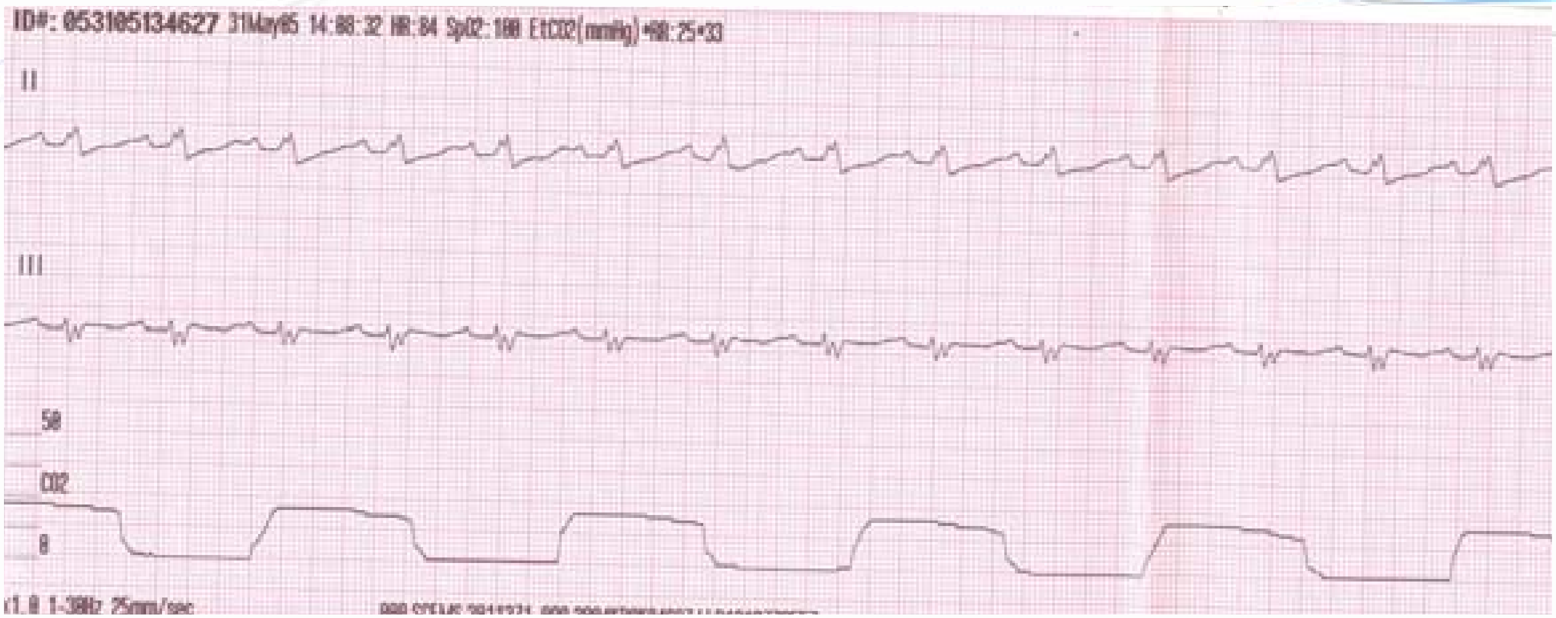
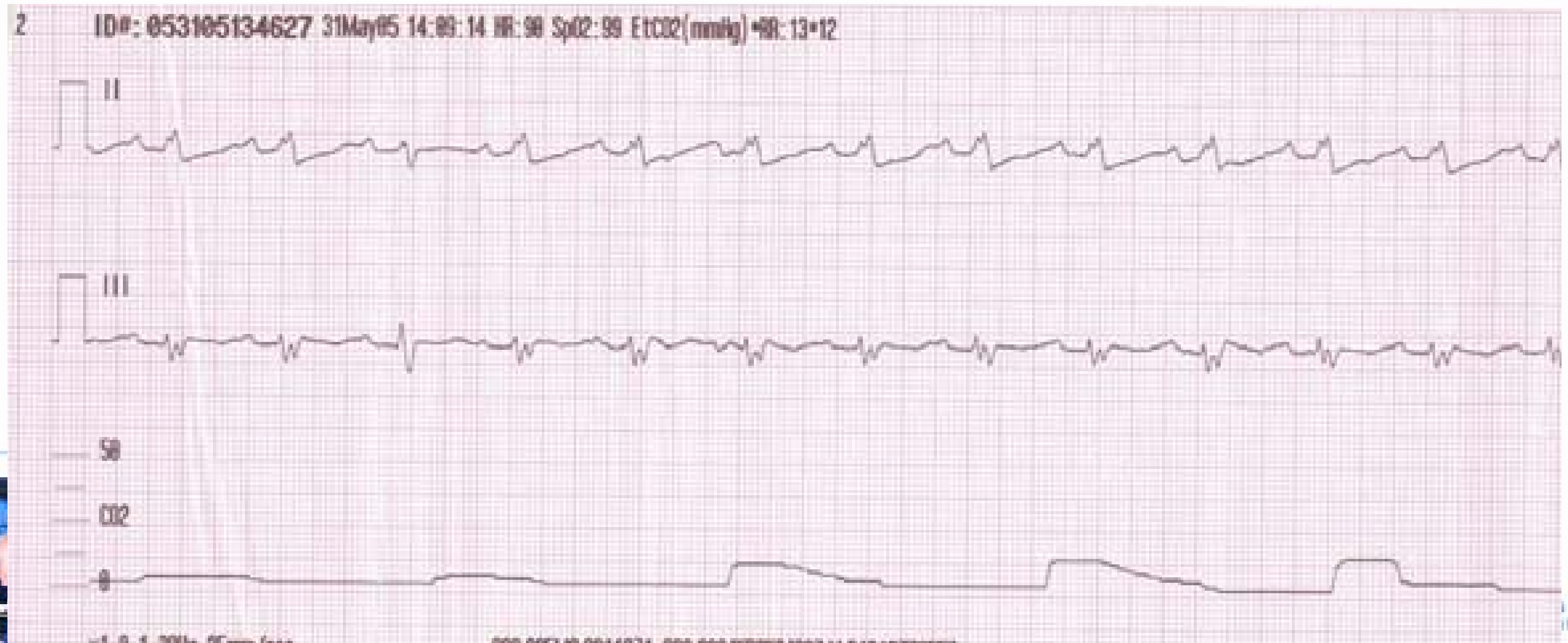
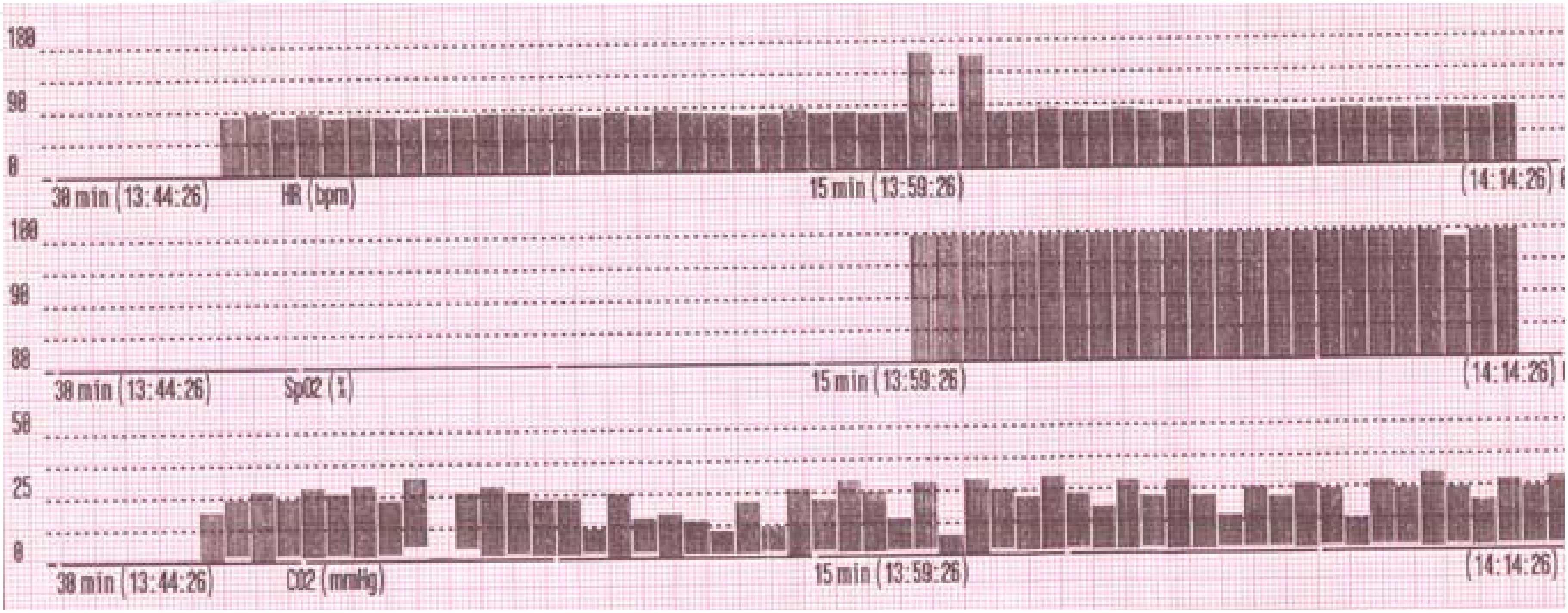
63 y/o female, found unresponsive in bed 1 hour after lunch. Hx CVA and IDDM

- VS – Initial
  - P-86, R-14 ,BP 112/76, GCS-8
- VS – 8 minutes later
  - P-88, R-40, $ETCO_2$ – 20, GCS-8
- VS – 17 minutes into patient care
  - P-84, R-14, BP 142/112, GCS-8, $ETCO_2$ – 30
- VS – 24 minutes into patient care
  - P-86, R-36, BP 150/120, GCS-8, $ETCO_2$ – 20
- Pulse Ox 100% on NRB entire time


ID#: 053105134627 31May05 14:08:32 HR:84 SpO2:100 EtCO2(mmHg)+RR:25+33
II
III
50
CO2
0
x1.0 1-30Hz 25mm/sec


2
ID#: 053105134627 31May05 14:09:14 HR:90 SpO2:99 EtCO2(mmHg)+RR:13+12
II
III
50
CO2
0
x1.0 1-30Hz 25mm/sec



Was the patient ventilating adequately during care?

What type of breathing pattern has been described and documented?

Detection of Metabolic Acidosis

- Assesses metabolic status providing information on how effectively CO2 is being produced by cellular metabolism.
- Recent studies have shown that EtCO2 and serum bicarbonate (HCO3) are linearly correlated in diabetes
- can be used as an indicator of metabolic acidosis in these patients

Capnography in Diabetics

- As the patient becomes acidotic, HCO3 decreases and a compensatory respiratory alkalosis develops with an increase in minute ventilation and a resultant decrease in EtCO2.
- The more acidotic, the lower the HCO3, the higher the respiratory rate and the lower the EtCO2.

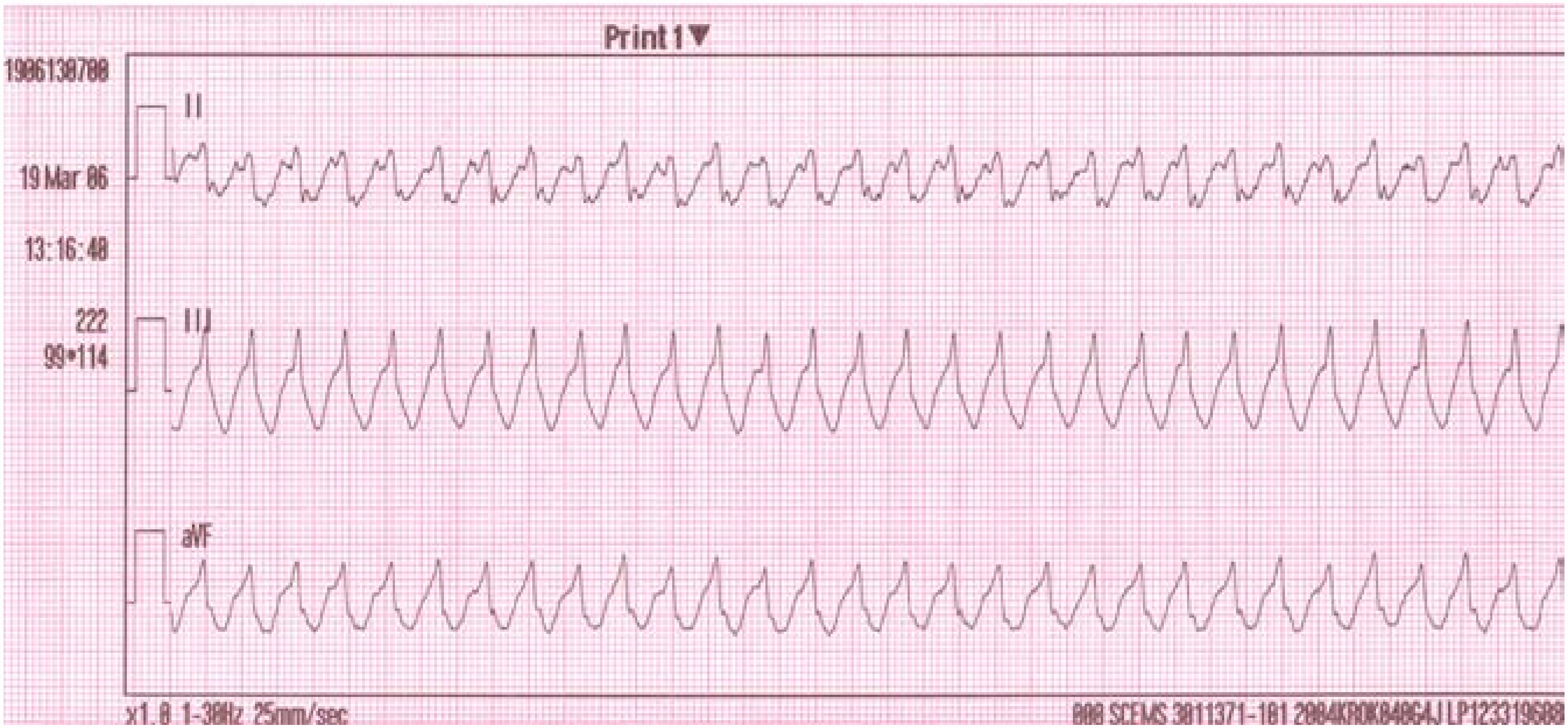
Capnography in Diabetes

- Ketoacidosis
  - metabolic acidosis
  - compensatory tachypnea, low $EtCO_2$
- HHNC
  - Nonacidotic
  - normal respiratory rate, normal $EtCO_2$

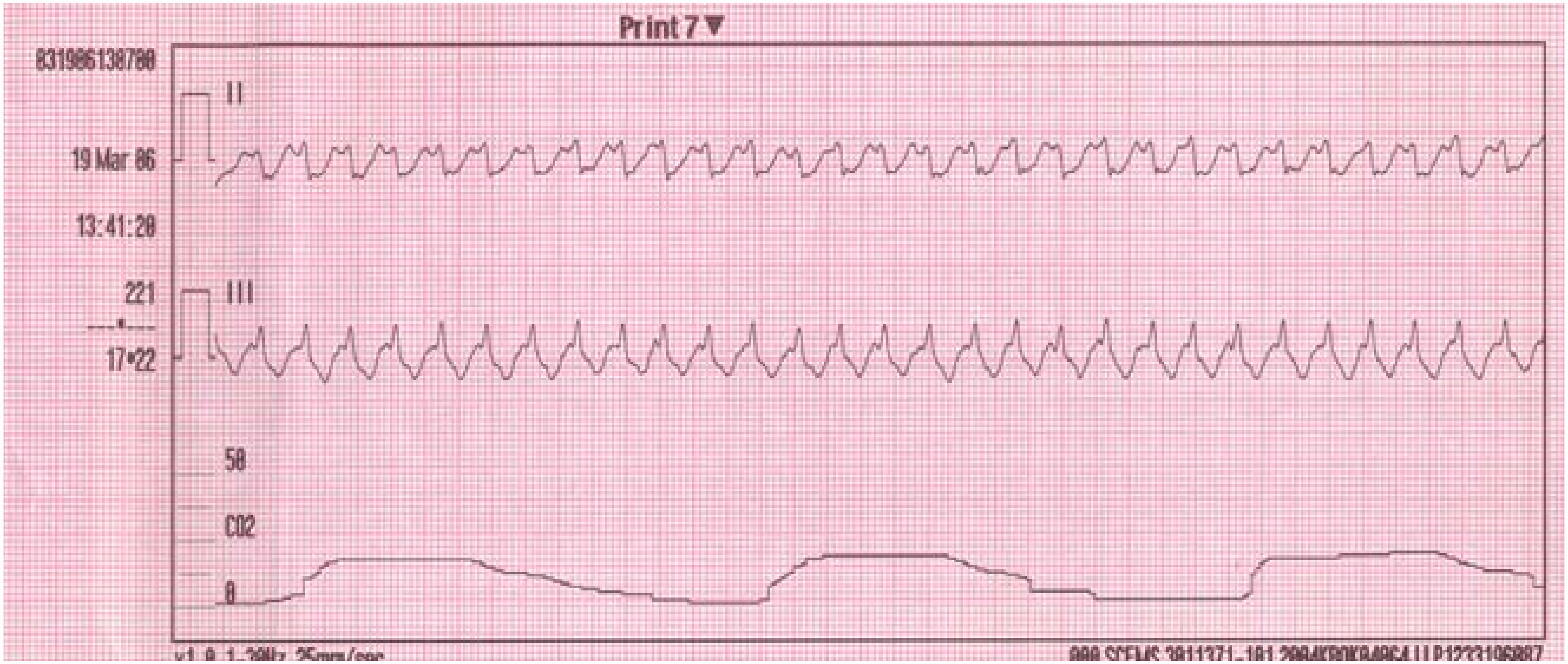
Why this Works

- $H^+ + HCO_3 \rightarrow H_2CO_3 \rightarrow H_20 + CO_2$
- As the body uses up it's stores of Bicarb to rid the acid it looses it's ability to transport Carbon Dioxide
- So as Dioxide levels fall it correlates to the lack of bicarb…..patient is acidotic.

86 year-old male "Something is not right."

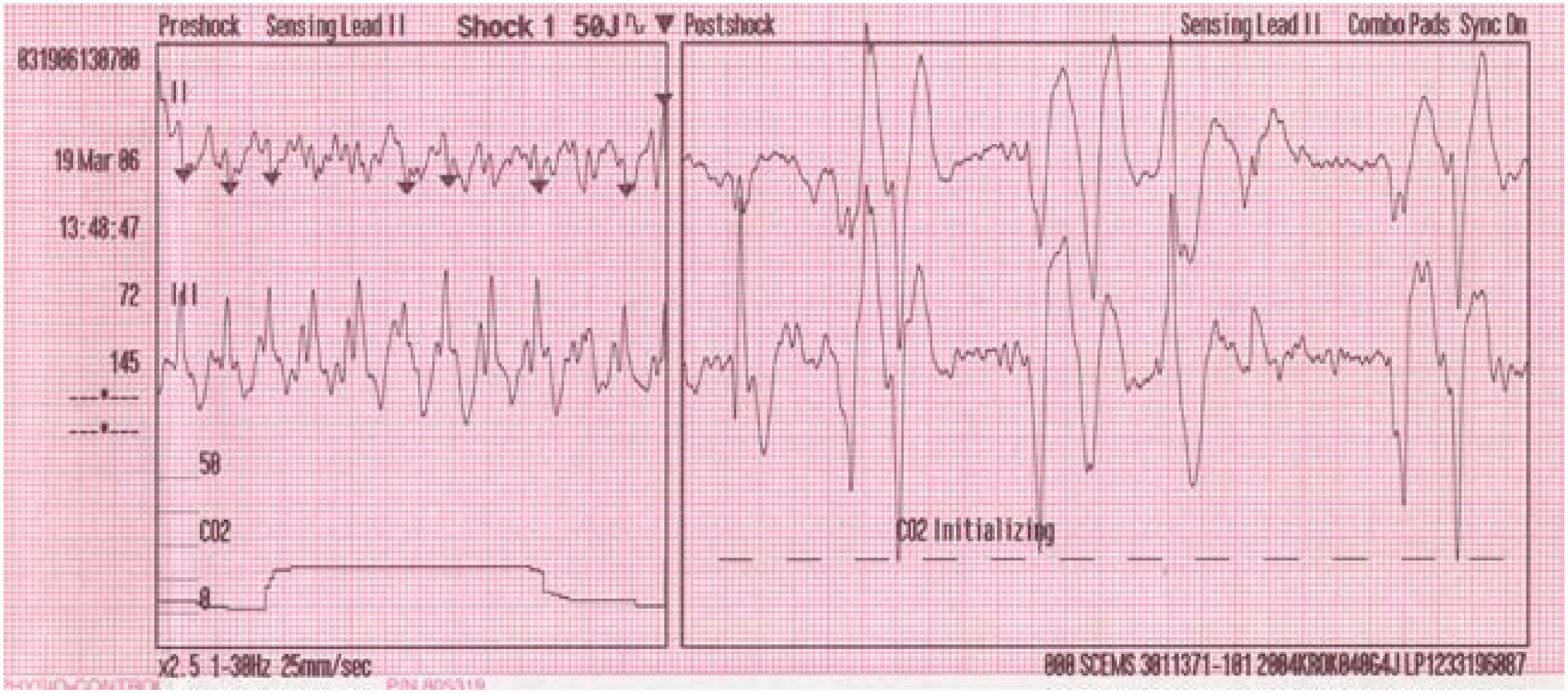


Capnography and Perfusion



How is the patient’s perfusion status?

Cardioversion

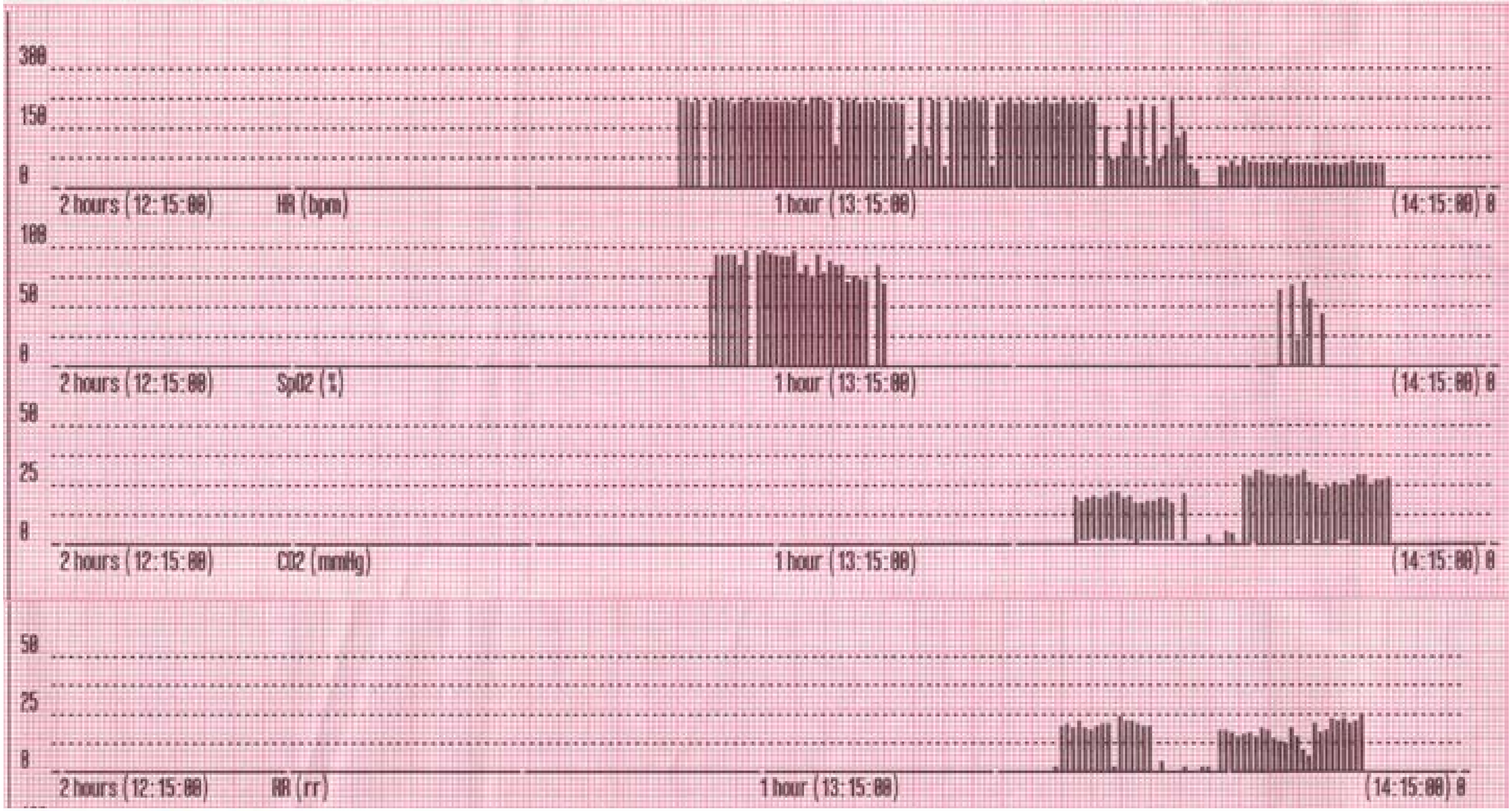


CO_2 Initializing post Defibrillation and Cardioversion

Capnography and Perfusion

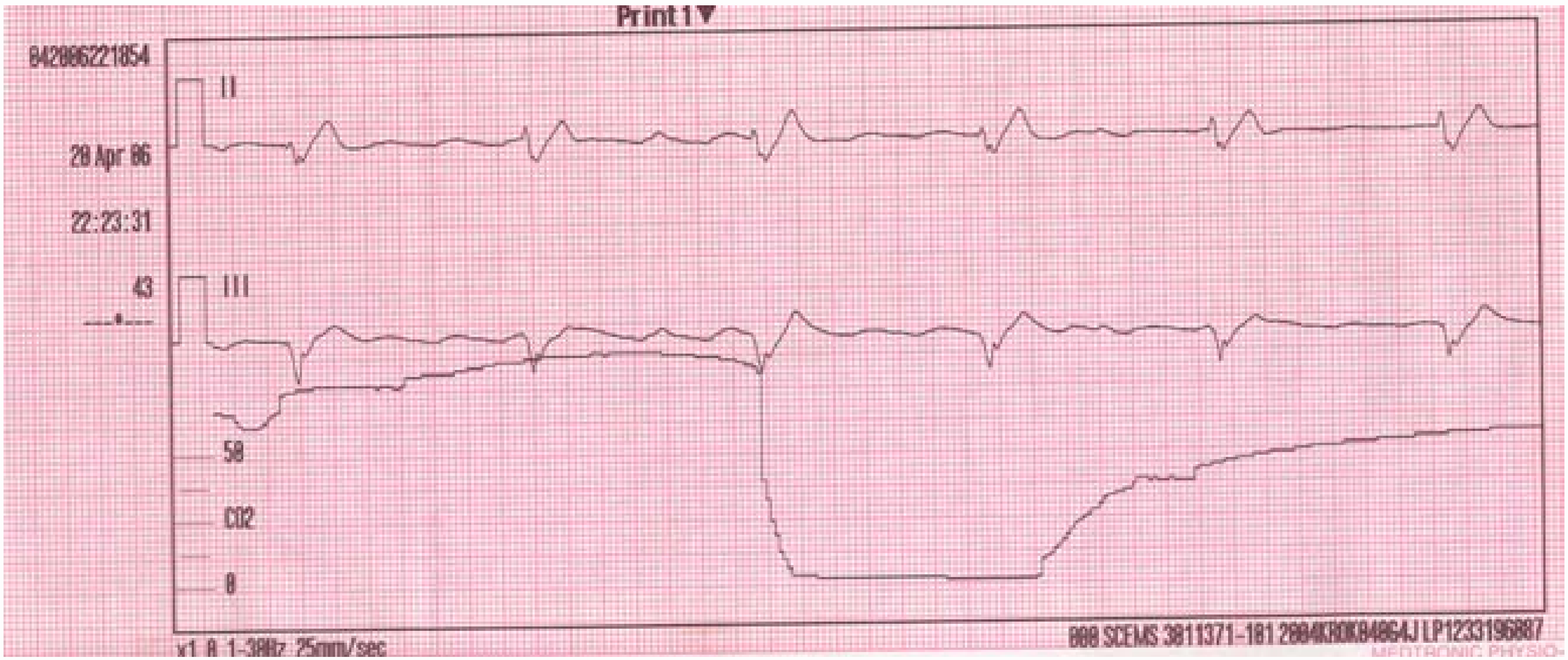
How is the patient's perfusion status?

Trend Summary



When every breath counts

67 year-old male Cardiac Arrest – COPD



Is the tube in the correct place?

How is the patient's perfusion status?

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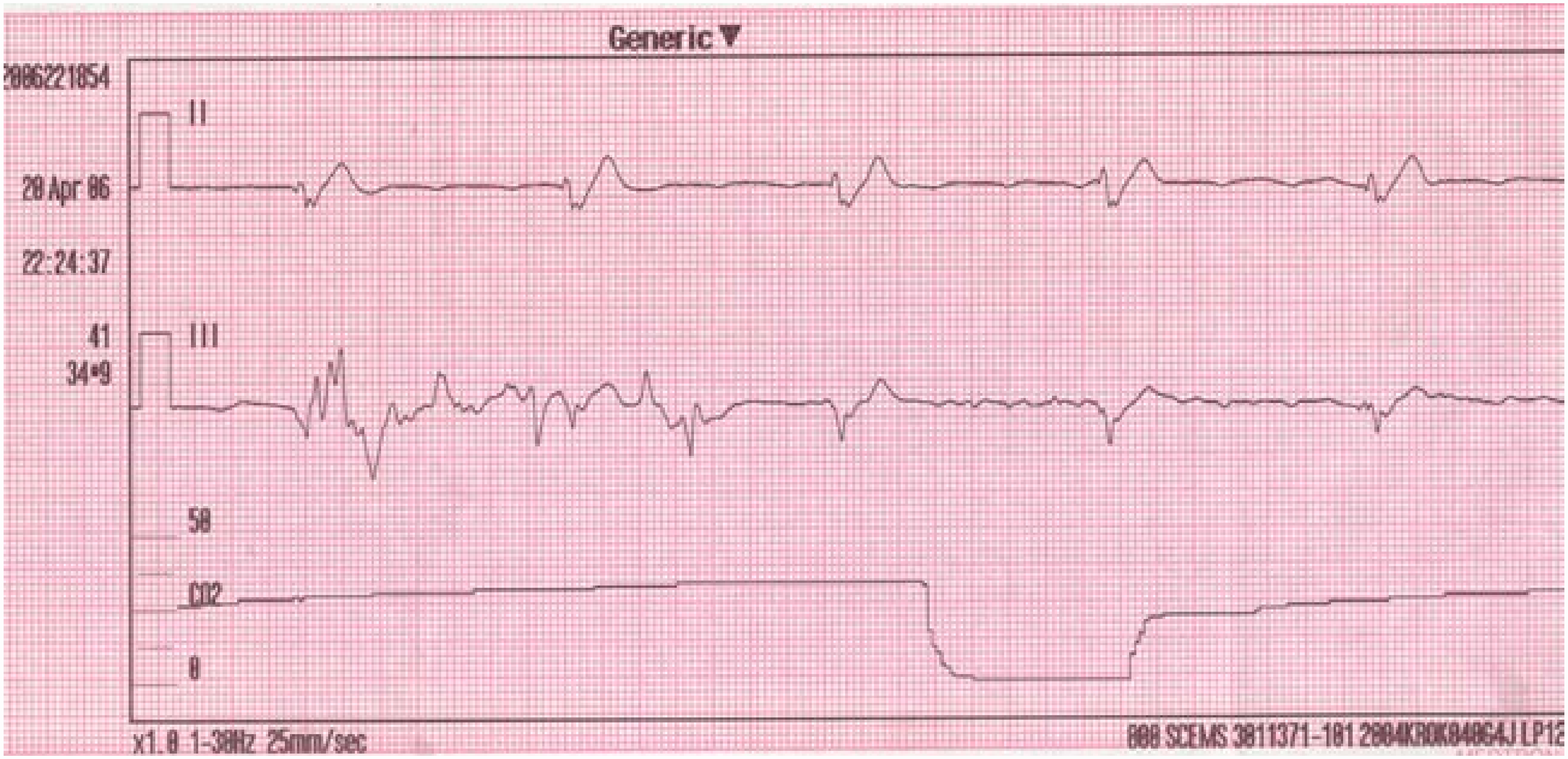
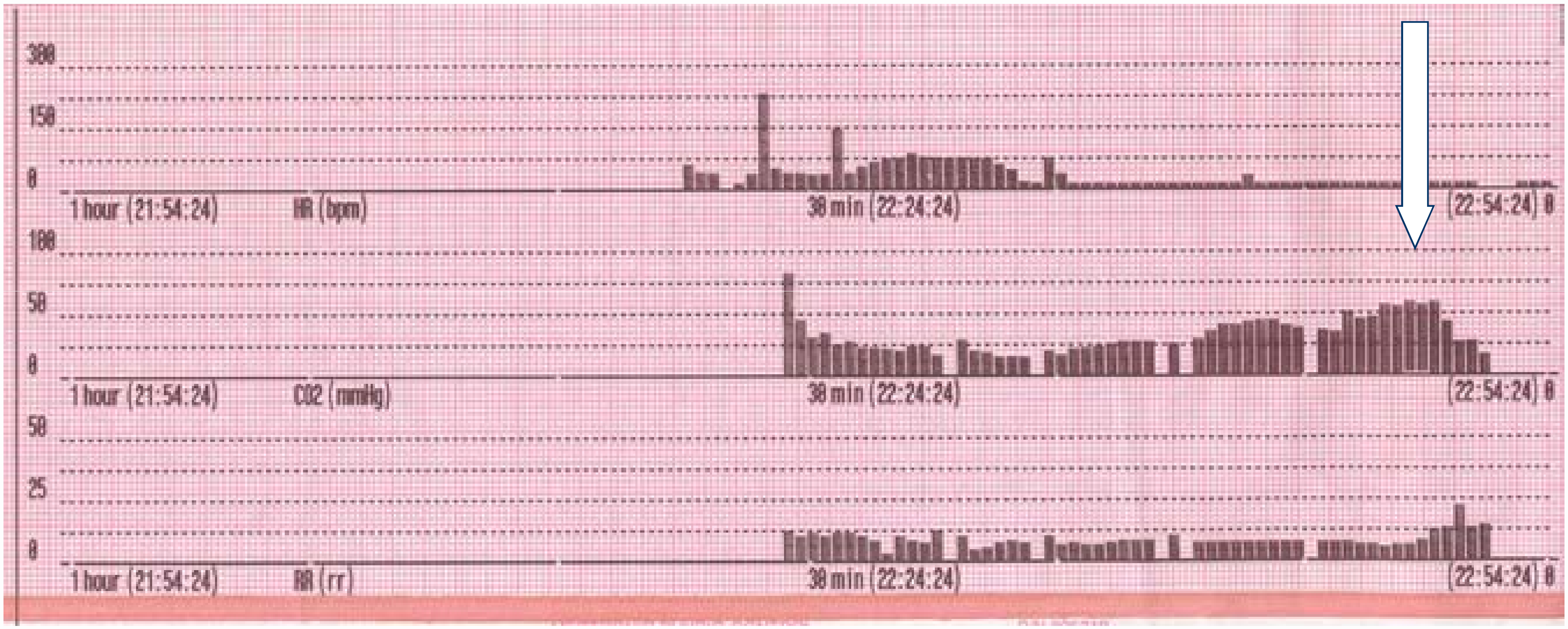
Perfusion Status???



Do we need to continue chest compressions?

Trend Summary



Other Waveforms

Abnormal Waveforms

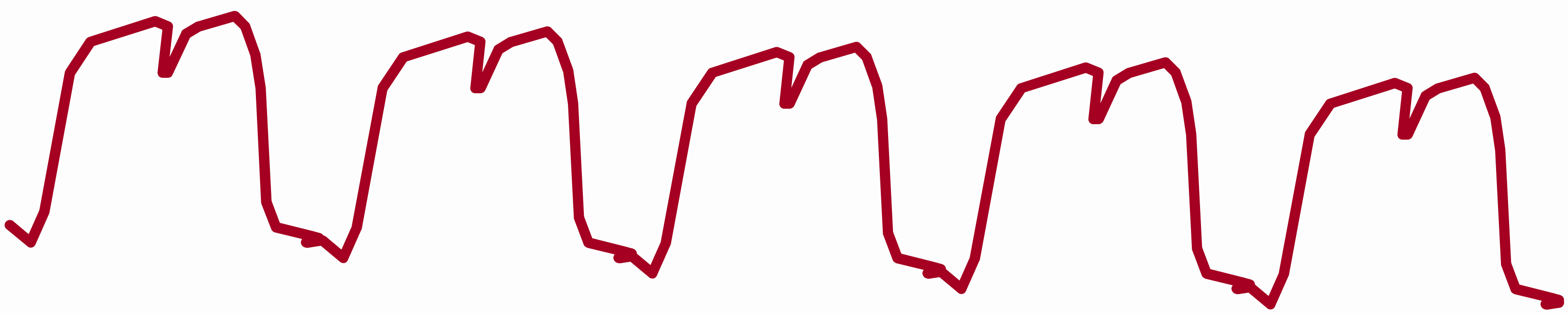
- **Gradual increase in $EtCO_2$**
  - Rising body temperature
  - Hypoventilation
  - Increased metabolism

Abnormal Waveforms

Sustained low $EtCO_2$ with a good plateau indicates either hyperventilation or a large physiological dead space ventilation, resulting in a widened a-$ADCO_2$.

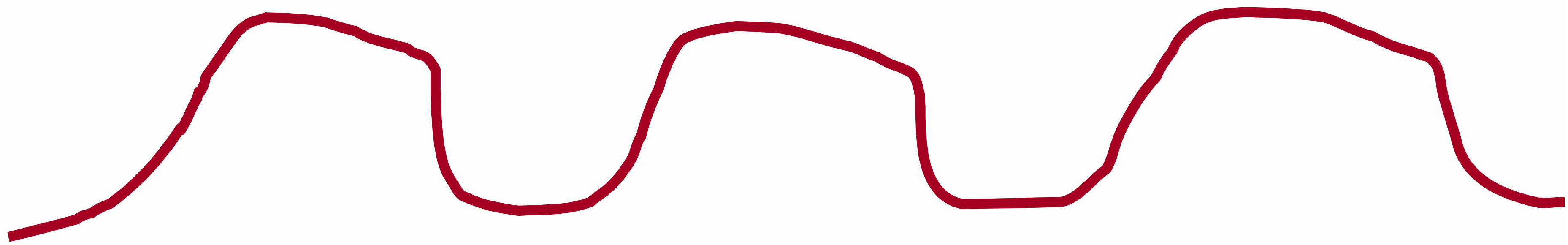
- ❖Pulmonary Emboli
- ❖Hypovolemia
- ❖ Hyperventilation
- ❖ COPD resulting in alveolar over-distension
- ❖ Excessive level of PEEP

Curare Cleft



Emphysema

- The slope of phase III can be reversed in patients with emphysema where there is marked destruction of alveolar capillary membranes and reduced gas exchange



Where to Get More Information

- Medtronic Physio-Control
  - Local Sales Representative
  - www.physiocontrol.com
- www.oridion.com
- www.capnography.com

Medtronic PHYSIO-CONTROL

Oridion CAPNOGRAPHY SOLUTIONS

Oridion Medical
1 888 ORIDION

Troy Smith
NREMT-P
troy@emstrainingsolutions.com