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CAPNOGRAPHY CASES VIRGINIA EMS SYMPOSIUM 2014:

Objectives

1) ***Identify:*** components of the capnography waveforms and the physiology behind the waveform

2) ***Apply*** capnography monitoring in critical care patients, through case studies…

3) ***Understand*** Capnography promotes ***Patient Safety*** by validating the patency of critical interventions, such as advanced airways and sedation.

Presentation

- Brief Review Capnography
  - History
  - Anatomy and Physiology
  - Pathophysiology of respiration and ventilation
- Case Presentations
  - Capnography integrated with the critical care patient
  - “Advanced” application of capnography
  - Alternative Applications

Capnography 2014

- Applies to ***any patient requiring ventilation!***
  - Bag-mask
  - ETI and rescue airways
  - Transport vent
  - CPAP?
- Noninvasive applications
  - Monitoring patient respirations

Capnography 2014

- 2010 AHA Guidelines
  - Class I, LOE A
  - 100% Sensitive, 100% Specific
- Quantitative, continuous, waveform capnography
  - Monitor position of airway devices
  - Quality of CPR
- “C-A-B” approach
  - Circulation-Airway-Breathing

AHA Recommendations

- The recommendations for airway management have undergone 2 major changes:
  - (1) the use of quantitative waveform capnography for confirmation and monitoring of endotracheal tube placement is now a class I recommendation in adults; and
  - (2) the routine use of cricoid pressure during airway management is no longer recommended.

AHA Levels of Evidence

SIZE OF TREATMENT EFFECT →

ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT

	CLASS I *Benefit >>> Risk* Procedure/Treatment **SHOULD** be performed/ administered	CLASS IIa *Benefit >> Risk* *Additional studies with focused objectives needed* **IT IS REASONABLE** to perform procedure/administer treatment	CLASS IIb *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment **MAY BE CONSIDERED**	CLASS III *Risk ≥ Benefit* Procedure/Treatment should **NOT** be performed/administered **SINCE IT IS NOT HELPFUL AND MAY BE HARMFUL**
LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Sufficient evidence from multiple randomized trials or meta-analyses
LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Evidence from single randomized trial or nonrandomized studies
LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation's usefulness/efficacy less well established ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Only expert opinion, case studies, or standard of care
Suggested phrases for writing recommendations†	should is recommended is indicated is useful/effective/beneficial	is reasonable can be useful/effective/beneficial is probably recommended or indicated	may/might be considered may/might be reasonable usefulness/effectiveness is unknown/unclear/uncertain or not well established	is not recommended is not indicated should not is not useful/effective/beneficial may be harmful

First Priority Application

- Confirmation of Intubation
  - Clinical Assessment
    - ***Visualization***
    - ***Auscultation***
    - ***Observation***
- ***Definitive confirmation!***
  - Chest X-ray: Single point in time
  - Qualitative Detector: Single point in time
- ***Capnography!: Continuous verification of placement***

PATIENT SAFETY

ABOVE ALL, DO NO HARM

Clinical Assessment

- Adequate Oxygenation
  - New guidelines titrate to 95-97%
- Adequate Ventilation
  - Quality chest-rise and fall
- Avoid tunnel vision
  - Use your tools, know their limitations
- Perfusion to Cells

- ***Quality over Quantity***

HYPOXIA KILLS

Intubation RE-Confirmation

- Bag-Valve Movement
- Re-adjustment of ET placement
  - “Pull back 3 cm”
- When you move the patient…
  - Floor to stretcher
  - Stretcher to ambulance
  - Load/unload
  - Stretcher to stretcher
- Patient Self-Extubation
  - Is their problem fixed??!!

Capnography

- Quantitative, graphical measurement of instantaneous CO_2 concentration
- American Society of Anesthesiologists (ASA) standards:
  - *Every patient receiving anesthesia shall have adequacy of ventilation continually evaluated*
  - *Continual monitoring for the presence of expired carbon dioxide shall be performed unless invalidated by the nature of patient, procedure, or equipment*
  - *Continual EtCO2 analysis, in use from the time of ET placement, until extubation/removal or transfer …shall be performed using a quantitative method, such as capnography, capnometry, or mass spectroscopy*

EVERY INTUBATED PATIENT..

Continuous Monitoring…

Quantitative..

History of Capnography

- Developed in 1961 (For practical purposes)
- Expensive and bulky product limited to OR anesthesia
- In mid 1980s, anesthesia related fatalities led to need for improvements in airway management
  - Malpractice costs rise 1975 to 1985

History of Capnography

- 1988: Anesthesia standardized use of pulse oximeters and capnography
  - Malpractice claims from hypoxic related injury almost eliminated -Massachusetts
  - Insurance claims from anesthesia drops from 11% to 3% over 15 years
  - In 2002, anesthesia insurance premium was $18,000, the same as it was in 1985

Integration of Capnography

- In Anesthesia, capnography is an industry standard
- In EMS, it is the standard, but not there are variables
  - Waveform versus colormetric
  - ***Comfort*** leads in increased application
- Emergency Departments and ICUs now monitor capnography:
  - ***Application varies***

Newer Articles:

- United Kingdom study: equipment often not available and staff with limited comfort
- Capnography key monitoring tool for conscious or moderate sedation

Capnography Requirements

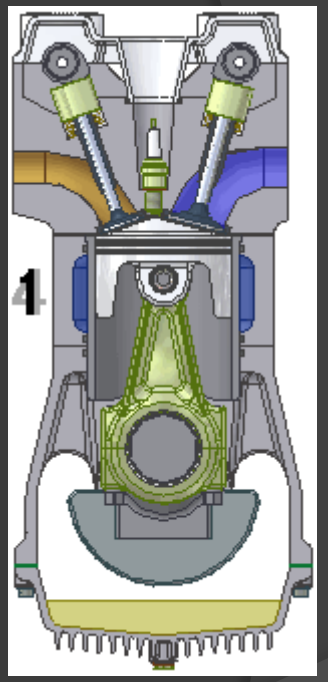
- Proper set equipment setup
- Understanding of what the numbers mean
- Limitations and idiosyncrasies

A&P for Capnography:

- What is important:
  - Air movement
  - Surface area of lungs
  - Blood flow to lungs and body
- Respiratory Cycle
  - Alveolar level
  - Cellular level

Review of Metabolism

- Aerobic:
  - Oxygen and Glucose metabolize to produce Energy to do work
  - Carbon Dioxide and Water are the byproducts
  - Krebs Cycle
  - Most efficient process
    - Improves with exercise



Review of Metabolism

- Anerobic:
  - Lack of oxygen causes build up of acids
  - Lactic Acid and Pyruvic Acid
- Buffer System
  - Hydrogen Ions of the Acid (pH) combine with Bicarbonate to form Carbonic Acid
  - This breaks down into water and carbon dioxide
  - Increased CO_2 stimulate increased ventilation rate to remove it

Carbon Dioxide

- By-product of normal respiration
- Measured as a Partial Pressure
  - 35-45 Mm/Hg
- Measured as a Percentage
  - 5-6%
- Key for: respiratory drive, pH balance
- Considered “acidic”

Drive to Breathe

- CO_2 triggers breathing
- NOT ENOUGH
  - Hypoventilation leads to hypercarbia
  - Hypercarbia leads to respiratory acidosis
- TOO MUCH
  - Hyperventilation leads to hypocarbia
  - Hypocarbia leads to respiratory alkalosis

CO2 on the BRAIN

- Decreased CO2 from hyperventilation
  - Cerebral Vasoconstriction
- Indication: (old school)
  - Traumatic head injury/CVA
- GOAL: Maintain perfusion without worsening bleeding
  - End-tidal CO2 target is 35mm/Hg
- HYPERVENTILATION
  - 16 to 20 breaths/minute
  - NOT 60 breathes per minute

CO2 on the Brain

- Elevated CO2
  - Permissive Hypercarbia
  - Above 45mm/Hg
  - With adequate ***OXYGENATION!***
- Potential Benefits
  - Cerebral and systemic vasodilation
  - Increase cellular oxygen supply
  - Decrease oxygen demand

Atmospheric Gases

- Convert percentage to pressure
- Normal gas Percentage
  - Oxygen at sea level: 21%
  - CO2 and other gases: 1%
  - Nitrogen: 78%

What do the numbers mean?

- Oxygen and Carbon Dioxide
- Hypoventilation:
  - $O_2 < 60mm/Hg$
  - $CO_2 > 45mm/Hg$ (Hypercapnea)
- Hyperventilation:
  - $O_2 > 100mm/hg$ (SaO_2 above 98%)
  - $CO_2 < 35mm/Hg$

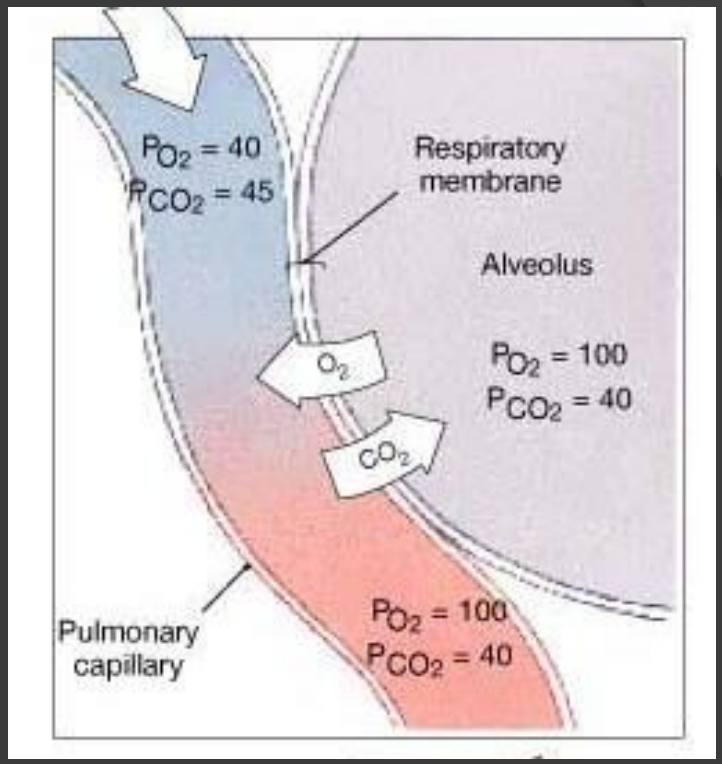
Dalton's Law: Partial Pressure of Gas

Total pressure of a gas is equal to the SUM of the partial pressures of the gas

- Atmospheric pressure is 760mm/Hg at sea level
- Under NORMAL conditions, all of the atmospheric gas pressures add up to 760
  - Oxygen is 159.2 mm/Hg
  - Nitrogen is 592.8 mm/Hg
  - CO_2 is 0.23 mm/Hg
  - Other gases, like Argon = 8mm/Hg

Partial Pressure

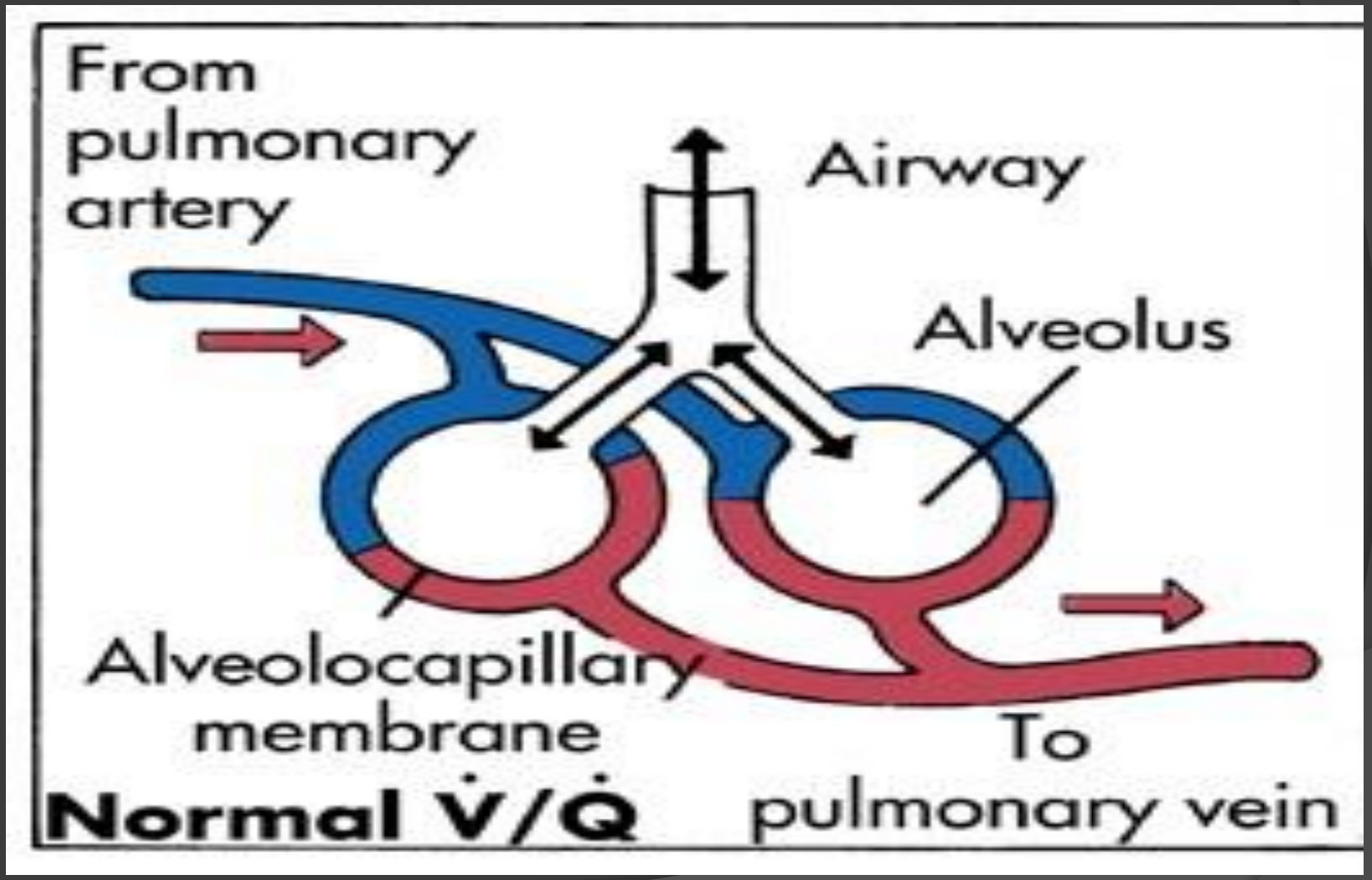
- Gradient
- The exchange of gases based on pressure gradient
  - Pressure forces Oxygen onto Hemoglobin



Pathology that Impacts CO2

- Ventilation Problems
  - Inability to move air in and out of the alveoli
  - Hyperventilation, hypoventilation
- Perfusion Problems
  - Oxygen transport to cells
  - Lack of blood flow
  - Ability of blood to carry oxygen

Normal Ventilation/Perfusion



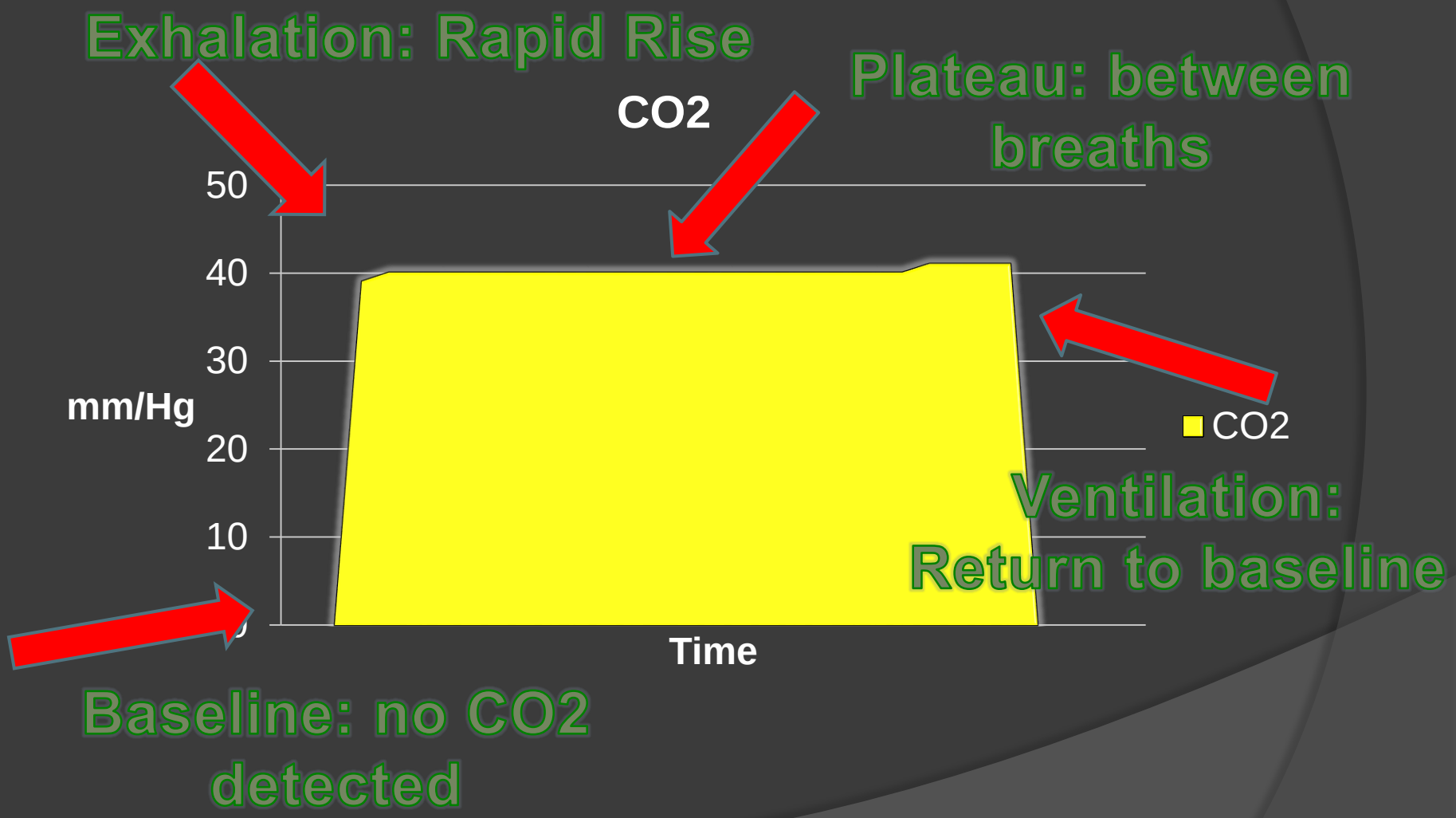
Clinical Conditions: Increased CO2

- Increased CO2 production
  - ***Bicarbonate administration, fever, seizures, sepsis, thyroid storm***
- Decreased alveolar ventilation
  - ***Hypoventilation, muscular paralysis, respiratory depression, COPD (retaining CO2)***
- Equipment Problem
  - ***Rebreathing, ventilator leak***

Clinical Conditions: Decreased CO2

- Decreased CO2 production
  - ***Cardiac arrest, hypotension, hypothermia, pulmonary emboli, pulmonary hypoperfusion***
- Increased alveolar ventilation
  - ***Hyperventilation***
- Equipment Problems
  - ***Airway obstruction, esophageal intubation, ETT leak, incomplete exhalation, poor sampling, ventilator disconnect***

Normal EtCO2 waveform



Sidestream vs. Mainstream

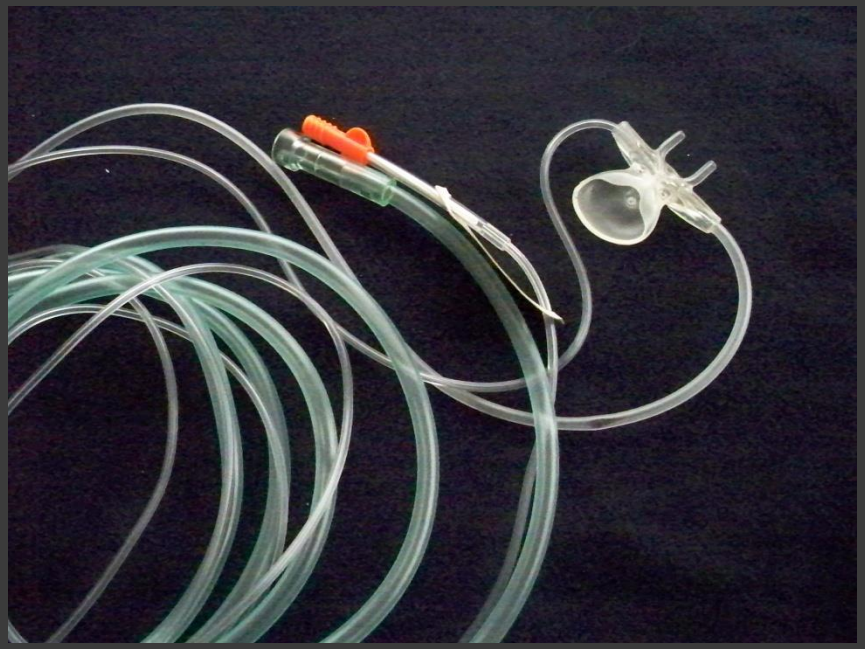
Sidestream

- Easier to use non-invasively
- Key is quality of the patient's respirations
  - Shallow is poor
  - Mouth breathing is challenging
  - Newer devices assist in increasing accuracy
- Sidestream is LESS specific because of its engineering

Side-stream Detector

Sidestream Detector

Cannula with mouth scoop



Oxygen and sensor

Mainstream Detector

- Sensor at end of cable
  - Disposable adapter to ET tube
- “Real time” values-best for critical care
  - As the gas passes the IR sensor
- Concerns:
  - Not easily adapted to non-intubated patient
  - Can be heavy for pediatric of infant ET tubes
  - Cable is expensive

Mainstream Detector

Troubleshooting!

False Positive

- May occur if patient ingested large amounts of carbonated beverage
- Limited IF continuous capnography in place: waveform may occur, then goes away
- Can deceive colorimetric detector

False Negative/Low EtCO2

- May indicate poor quality CPR
- Pulmonary Embolism
- Poor blood flow and delivery of CO2 to lungs
  - Poor Perfusion

Troubleshooting!

- Sudden loss of waveform
  - IMMEDIATE CLINICAL RECONFIRMATION
  - Lung sounds, SaO2, Anything else
- Place colormetric detector
- Clean/Clear sensor
  - Blockage
  - Vomit can clog
- Recalibrate/zero if able
- Replace adapter

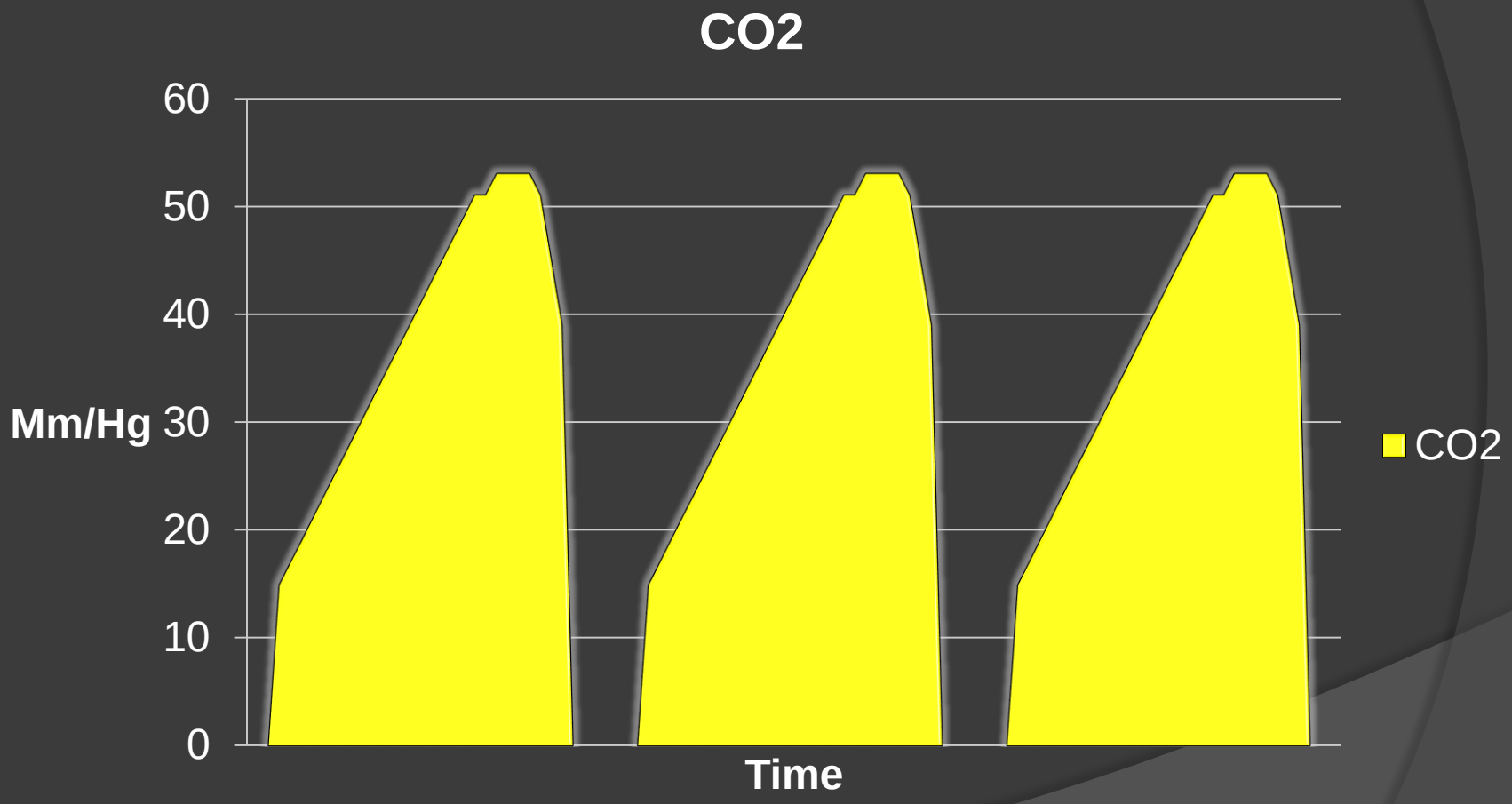
Case Presentations

- What are you seeing?
- What does your physical assessment tell you?
- What are your transport considerations?
  - Interventions?
- Differential Diagnosis?
- Trouble shooting?

Case 1

- Respiratory Distress
- 54 y/o COPD
- Respiratory Rate: 24
- Pursed lips

Case 1



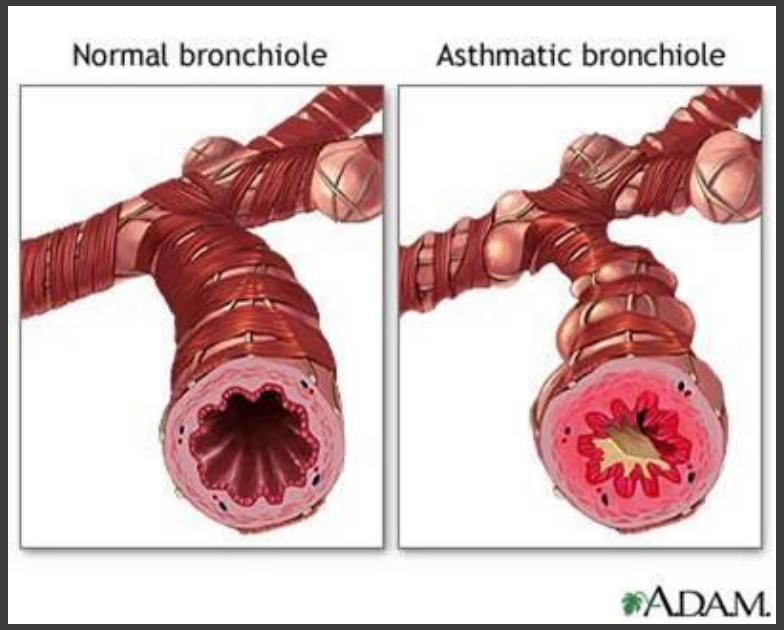
A wrinkle...Ami...

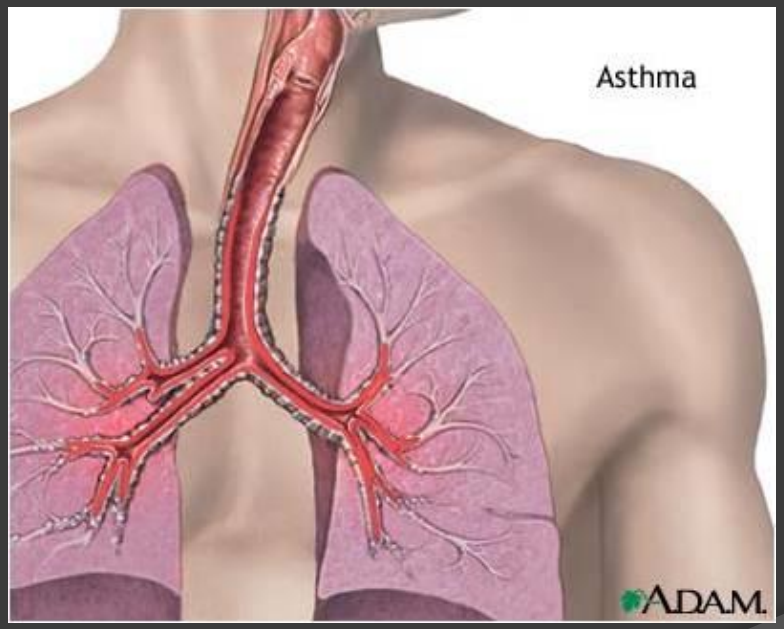
- EMS uses NRB mask as neb mask
  - “Partial Non-Rebreathing mask”
  - Uses flaps to allow exhalation
  - Only use oxygen
- How do you deliver your neb treatments?
  - Medical Air?
  - Oxygen?
- What are the effects of CO2 retention?

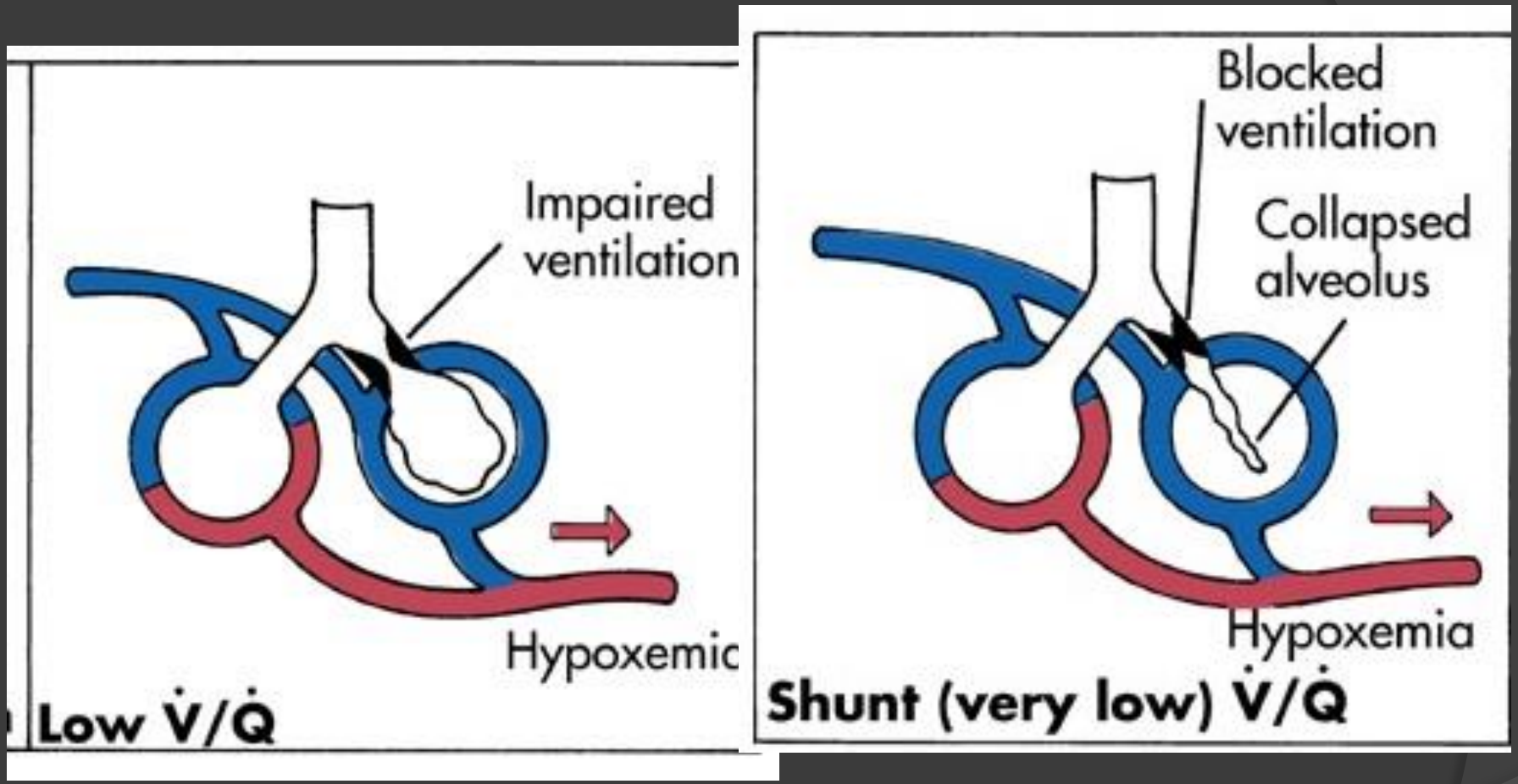
Obstructive Airway Disease

- Shunt problem
- Asthma, COPD, Emphysema
  - Swelling of airways/excess mucus
  - Airflow turbulent
  - Forceful expiration
- Different $EtCO_2$ presentations:
  - Mild=hyperventilation, low $EtCO_2$
  - Moderate=normal $EtCO_2$, waveform change
  - Severe=elevated $EtCO_2$, sharkfin

Asthma Pathology





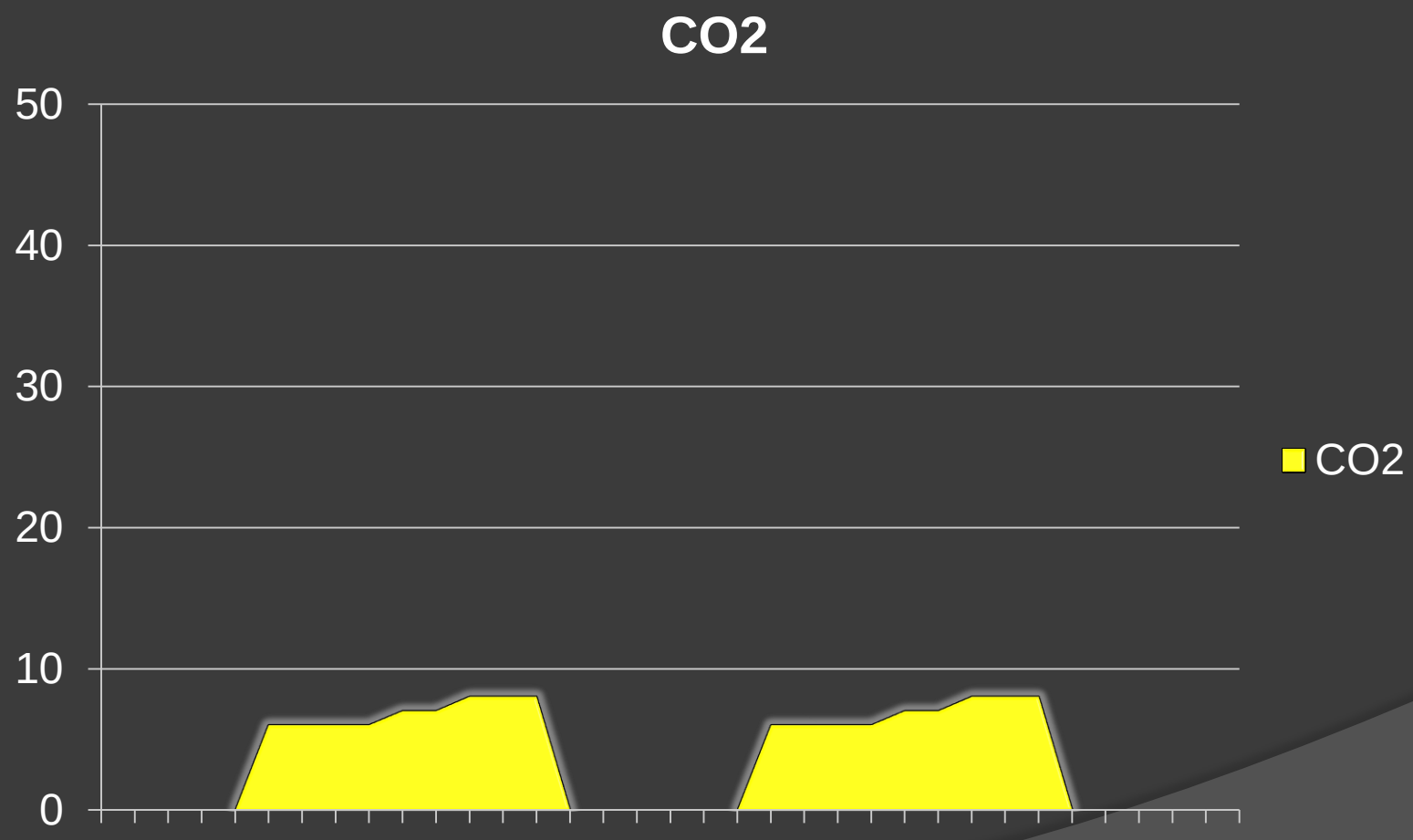


Impaired Ventilation Shunt Problem

Case 2

- 65 year old obese trauma patient
- Predicted Difficult Intubation
- Multiple Injuries
  - Chest Contusions
  - Abdominal Distention
  - Fractures of right upper leg, left lower leg, and right arm
- Intubation after progressive worsening of Respiratory Distress

Case 2



Case 2

- Initial Et CO_2 6-7mm/Hg
- Intermittent sensor detection of numerical value
- Waveform present
- Low “shark fin” appearance
- What is going on?
- Is the ET good?

Shock

- “A rude unhinging of the Machinery of Life”
  - Samuel Gross, 1872
- “A momentary pause in the act of death”
  - John Collins Warren, 1895
- “Pushing back the edge of death”
  - Judy Mikhail, 1999

Case 2

- Clinical Considerations:
  - Type of Shock?
- Interventions:
  - Ventilation?
  - Fluids?
  - Needle Decompression?
  - Vasopressors?

Shock

- Body's compensatory mechanisms working; vital sign changes
  - Altered mental status
  - Pale, clammy, diaphoretic
  - Increased heart rate and respiration
  - Decreased blood pressure

Shock and Capnography

- ***A Piece of the Puzzle***
- Anaerobic compensation for decreased perfusion:
  - Blood CO2 elevated
  - Ventilations increase
  - End tidal CO2 DECREASES
- Cardiac Output drops:
  - Vasodilation vs. hypovolemia:
  - CO2 decreased as detected by EtCO2

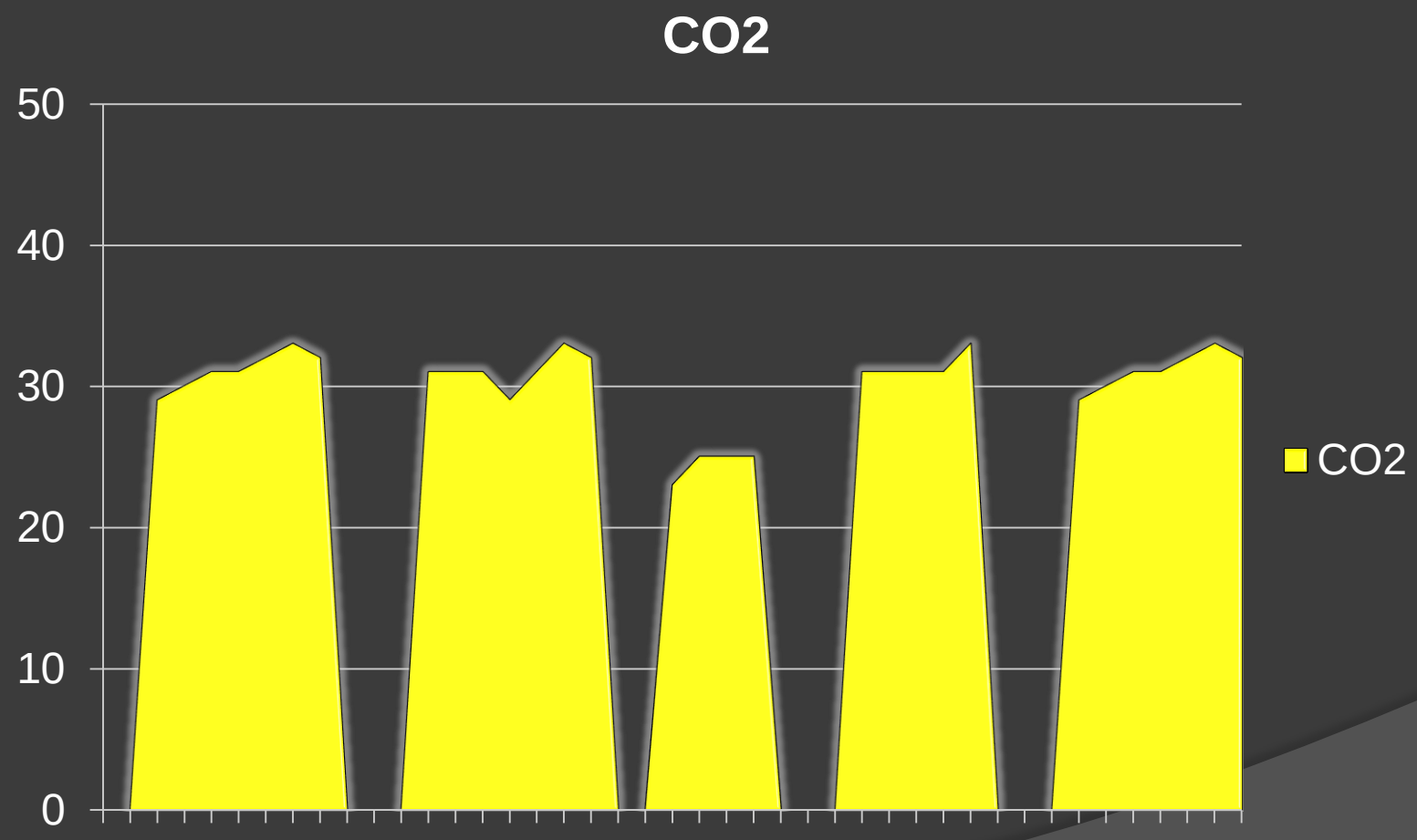
Shock and Capnography

- Index of Resuscitation
  - Quality of perfusion
  - Quality of ventilation
- A TOOL, like ALL monitors:
  - Understand its limitations
- Information HELPS GUIDE decisions
- CANNOT MAKE THE DECISION!

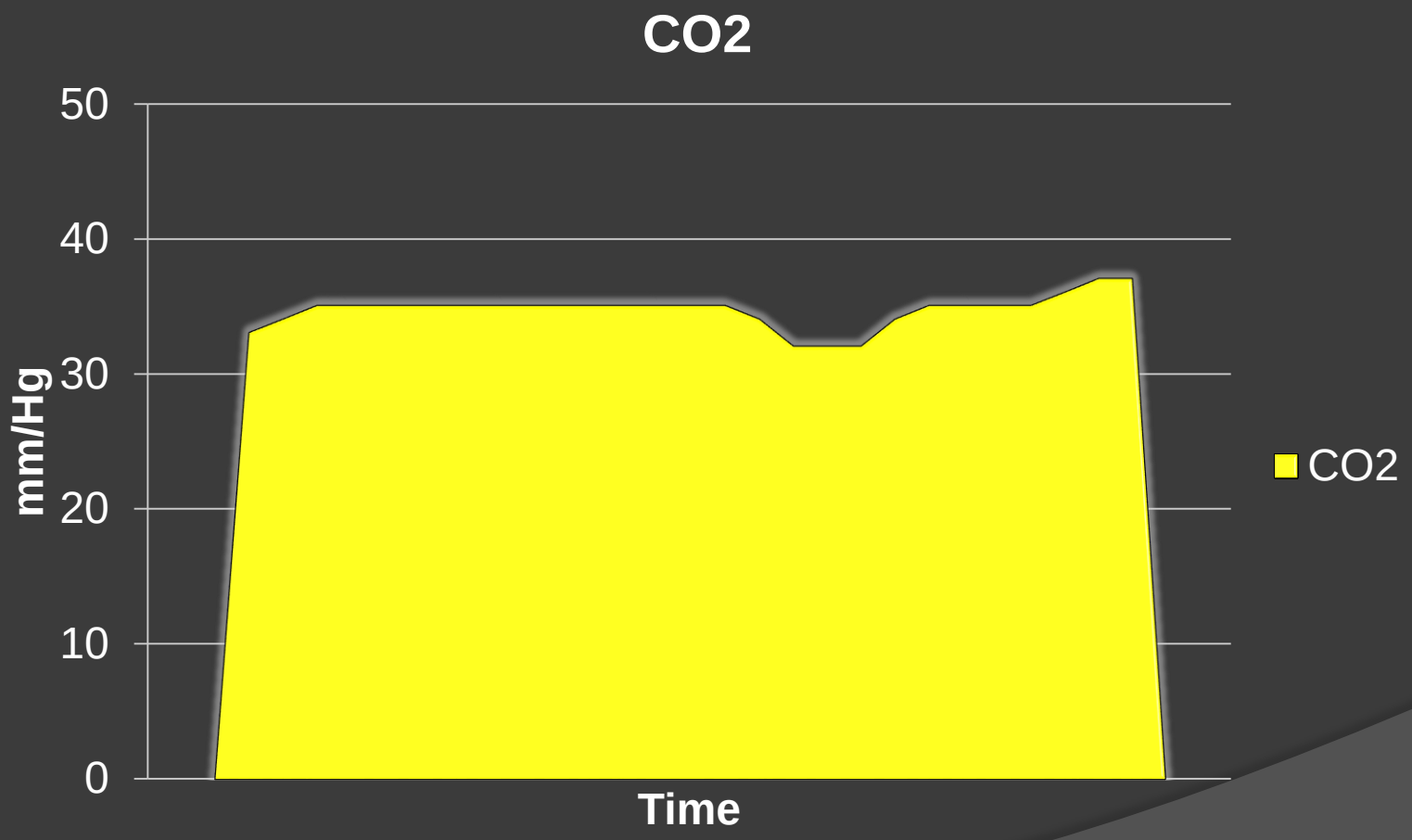
Case 3

- 26 year old MVC at community hospital
- Intubated in ED after becoming combative
- Vitals:
  - BP 164/92, HR 130, Respirations 24, SaO2 97%; on ventilator
- Ventilator Settings: Assist/Control
  - Rate 12, TV 500, FiO2 50%, PSV 10, PEEP 5

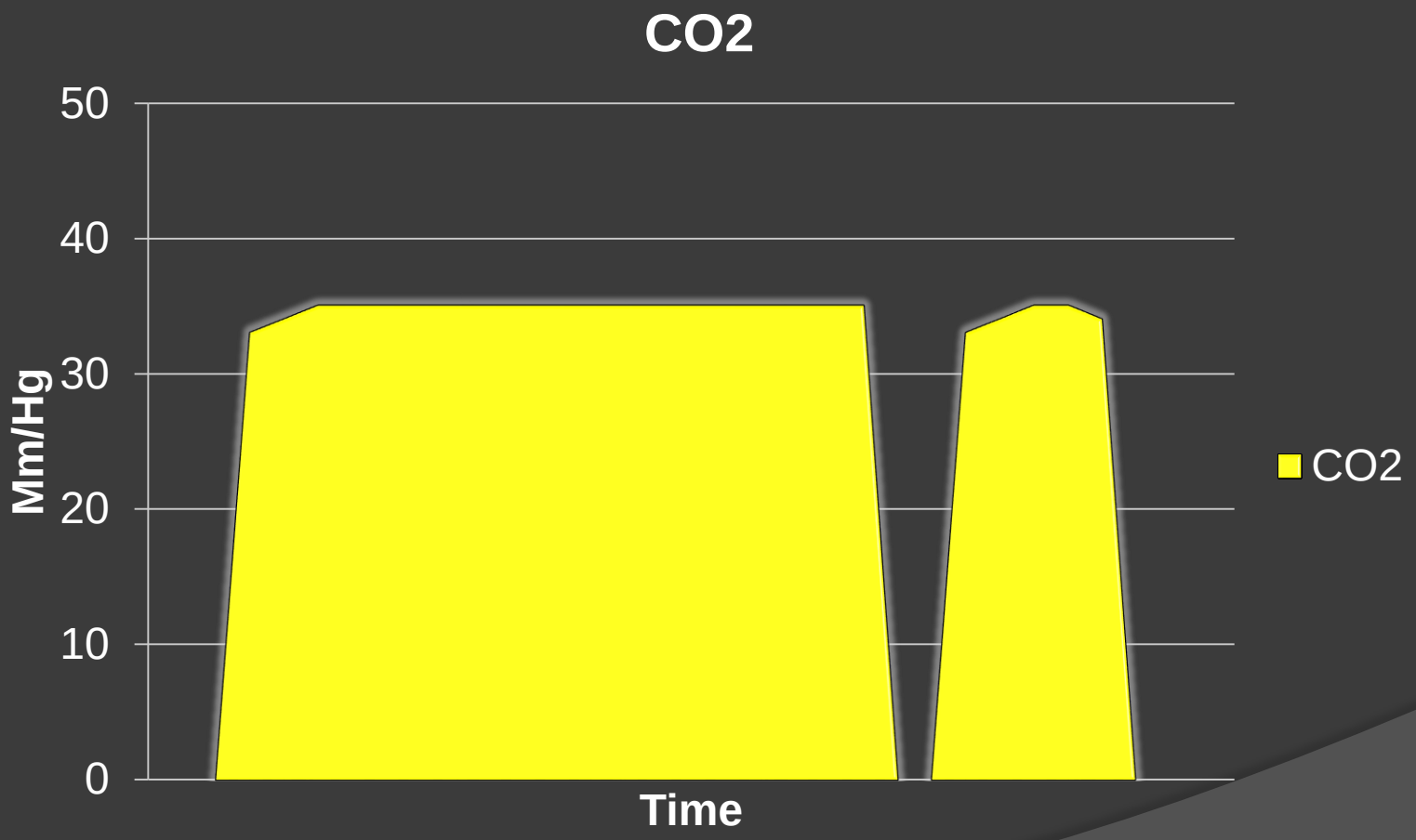
Case 3



Case 3



Case 3



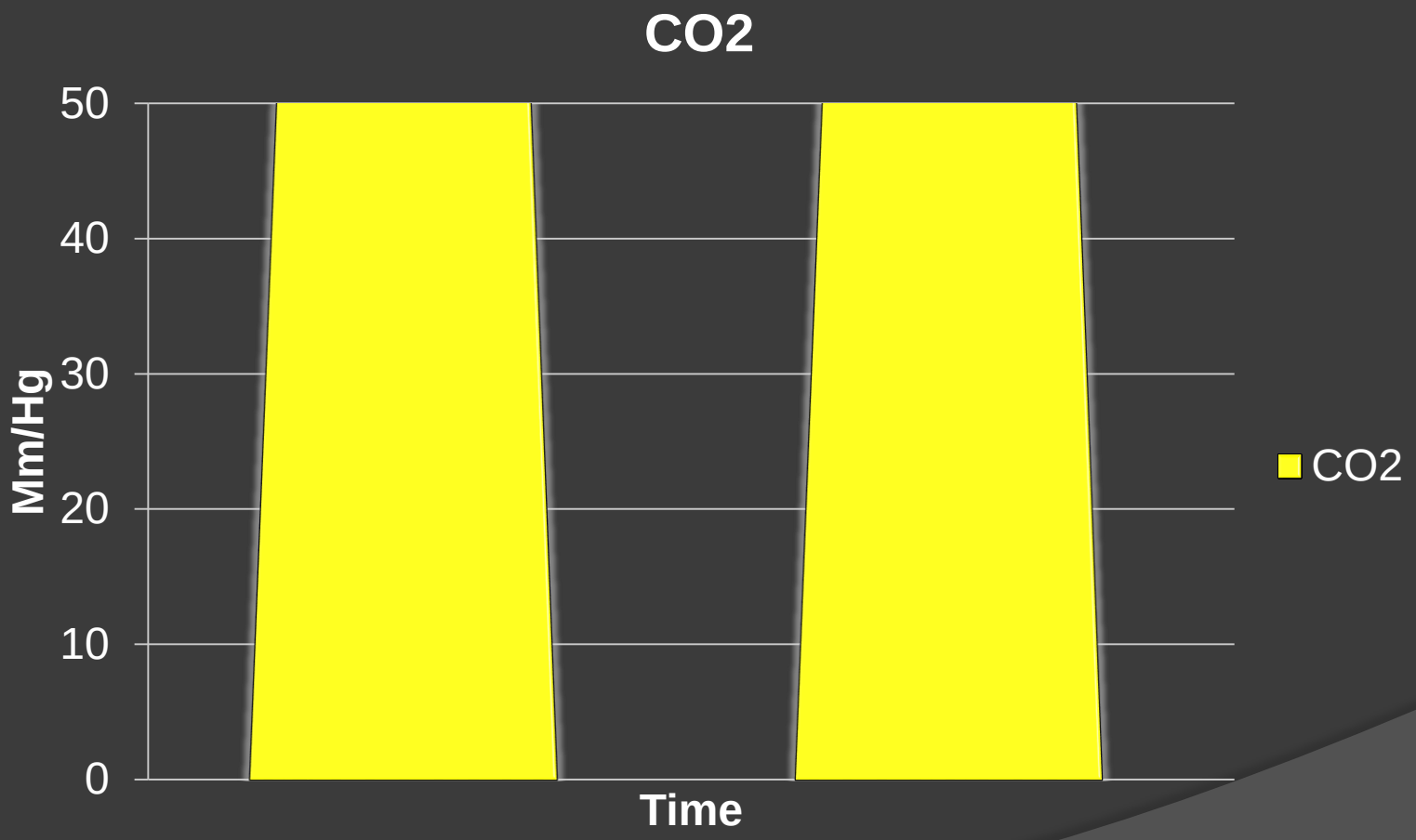
Case 3

- Clinical Considerations:
  - What is going on?
  - Distance to definitive care
  - Mode of Transport
- Interventions:
  - Settings changes
  - Medications

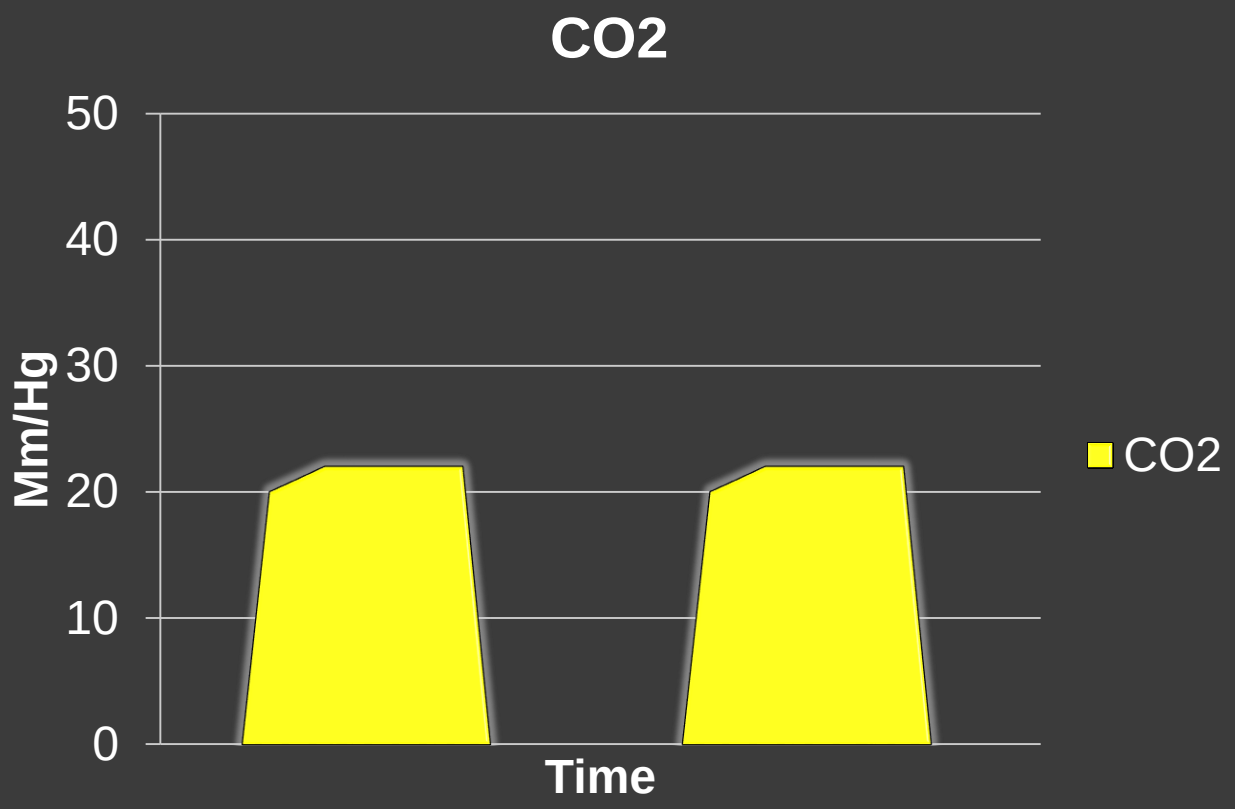
Case 4

- 50 year old cancer patient receiving radiation and chemo
- Presents with respiratory distress to EMS
  - SaO2: 85%, dramatic work of breathing, becoming tired
  - CPAP Trial; failed and became apneic
- Intubated without RSI
- Vitals: BP 140/88, HR 78, vented at 10 with SaO2 of 93% with 100% FiO2
- Initial EtCO2 is 85mmHg
- EMS: “something is not right with end tidal!”

Case 4: Initial



Case 4: After ventilator placed



Case 4

- Community ED requests transfer to tertiary care for Pulmonary Embolism
- Post Intubation ABG:
  - pH 7.31, PaO_2: 140, $PaCO_2$: 49mmHg, Bicarb 27
- CO_2 gradient:
  - $PaCO_2$ – $PetCO_2$ (49 minus 20 equals 29mmHg)
  - Normal gradient 3 to 5mmHg
- What is in the blood is not getting out

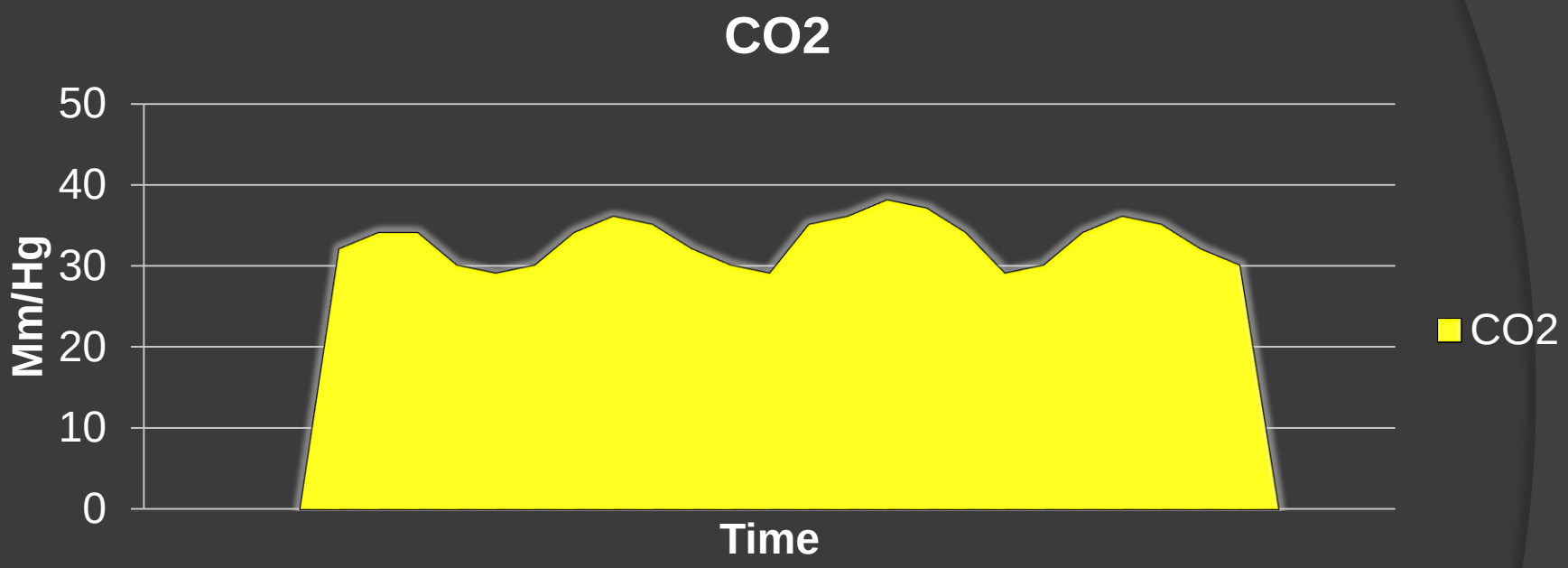
Pulmonary Embolism

- Dead Space Ventilation
  - Decreased EtCO2
- Clot breaks loose in blood vessel
  - Floats to and obstructs pulmonary vasculature
- Causes:
  - Post surgical
  - Sitting for extended time
  - David Bloom, NBC News in 2003

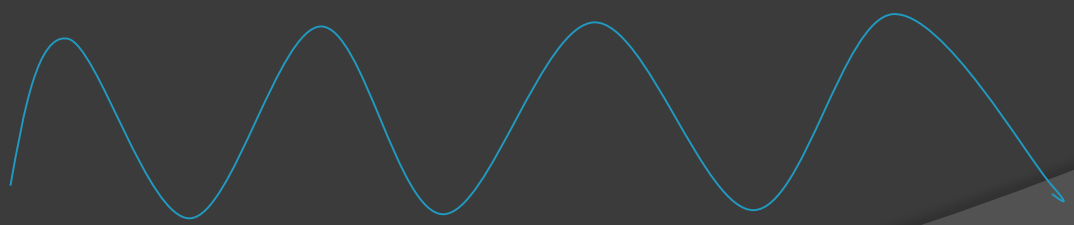
ABGs, pH, and Capnography

- Arterial Blood Gases assess for acid-base balance
  - Acidosis and Alkalosis
  - Mechanisms: Respiratory and Renal (Metabolic)
- pH is a measure of Hydrogen ion concentration (H+)
  - Normal is 7.35 to 7.45
  - Reflects balance between carbon dioxide and bicarbonate
- Capnography only represents the RESPIRATORY

Varient

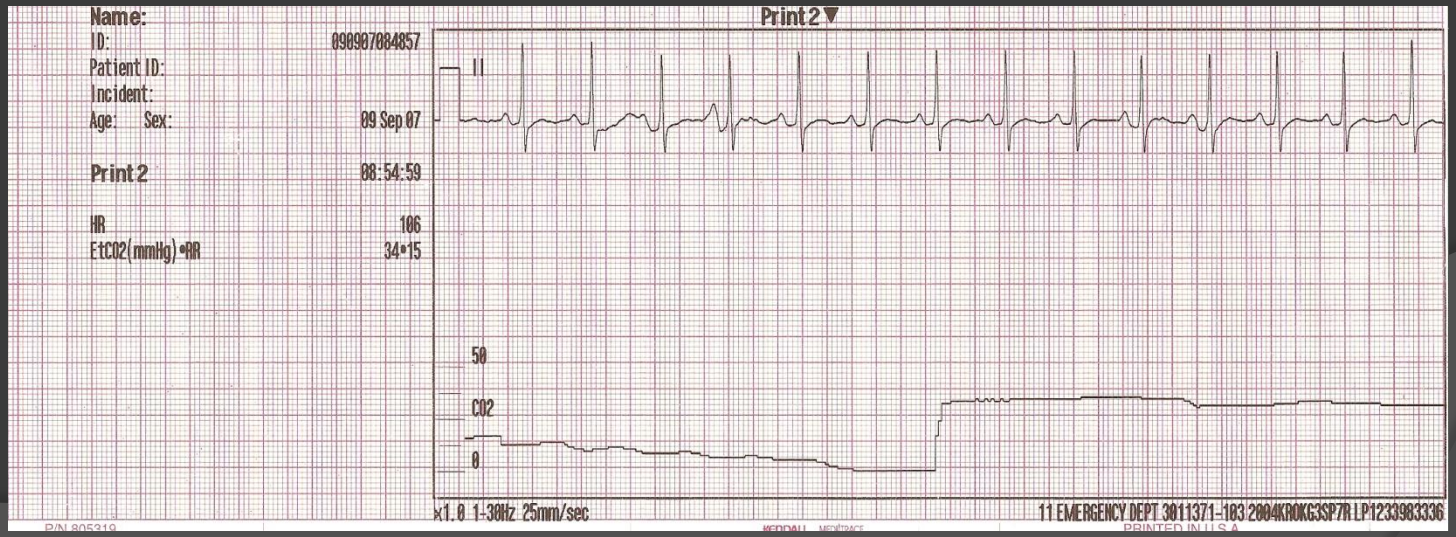


Pulse Oximetry

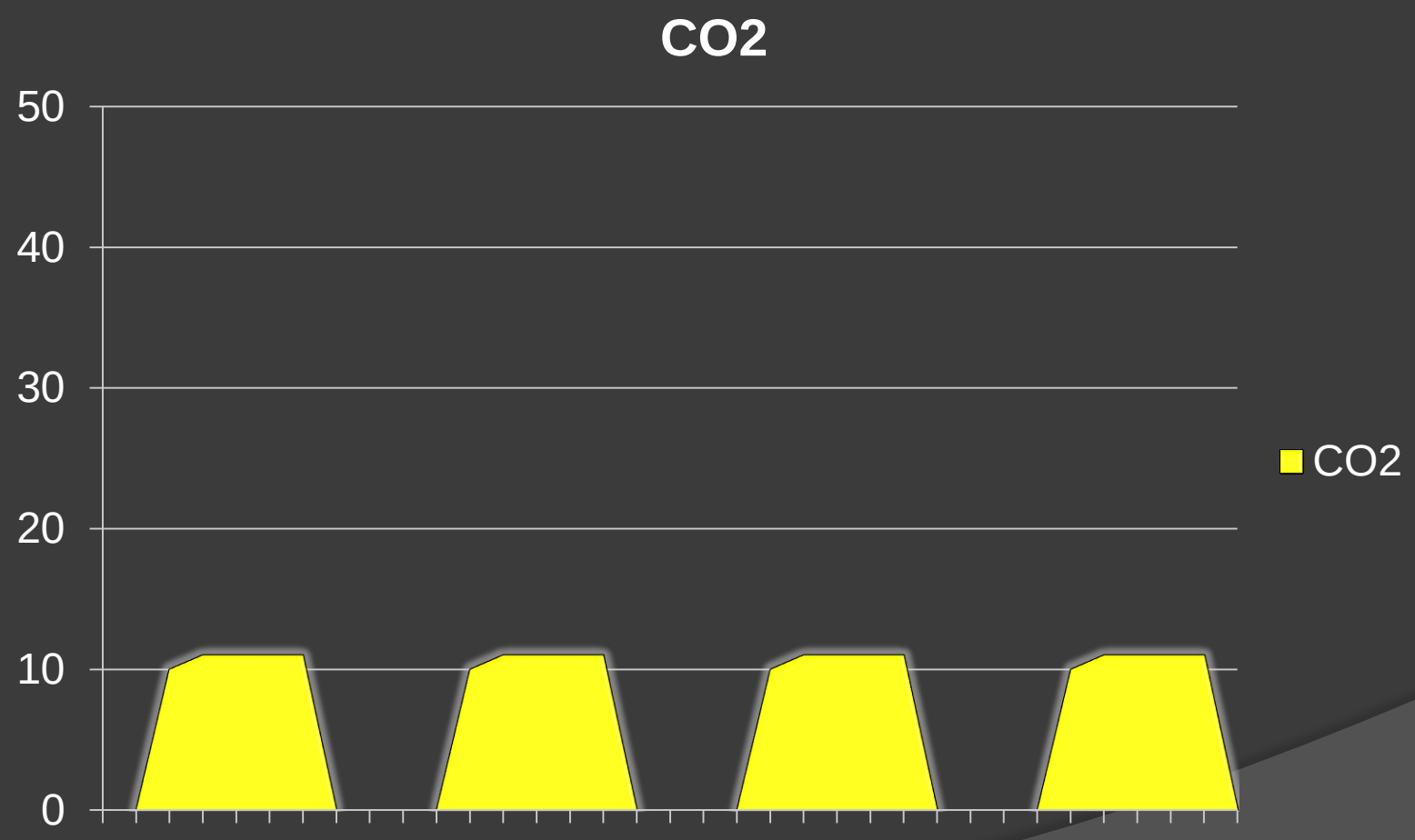


Case 5

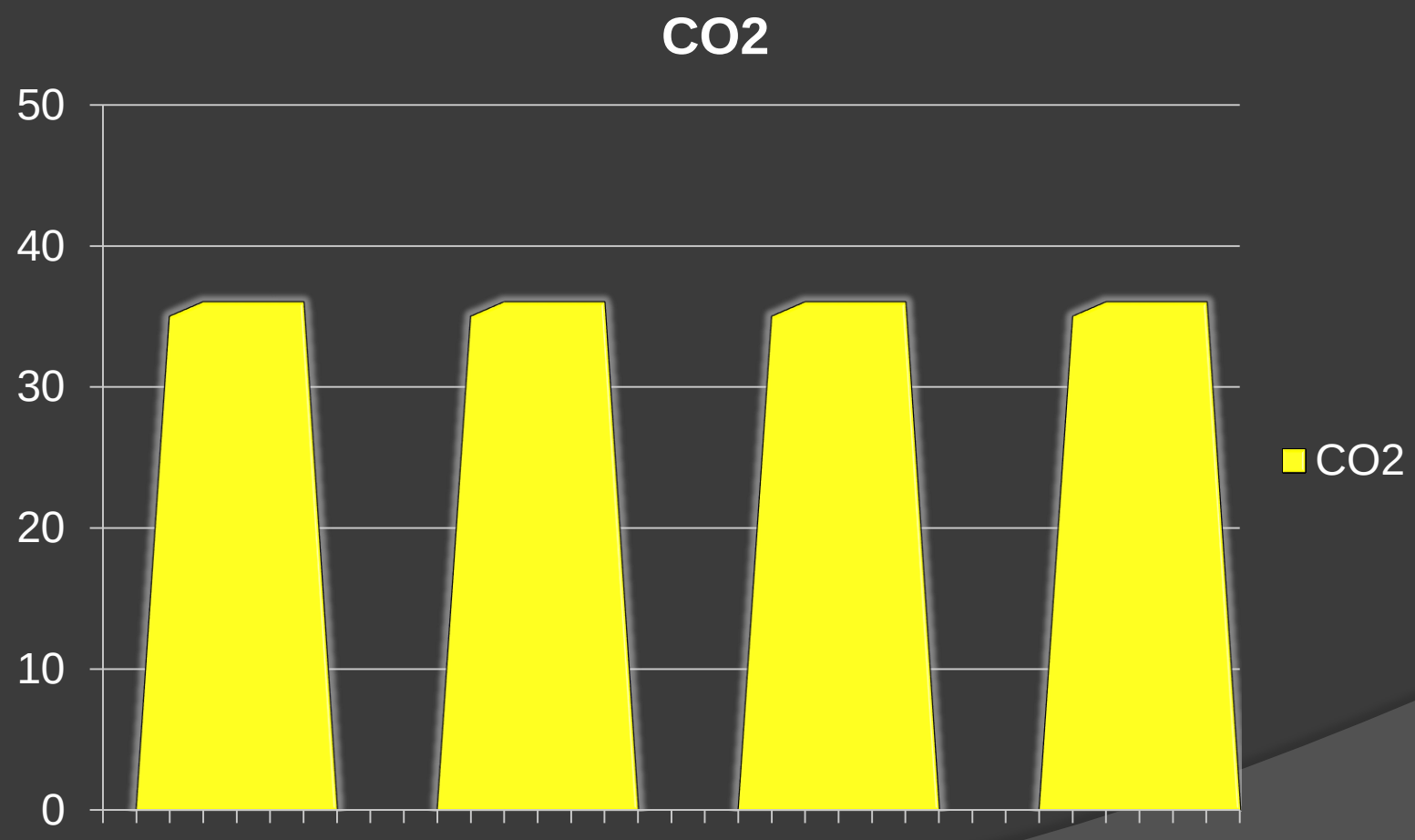
- 21 year old female
- Witnesses cardiac arrest on athletic track, defibrillated by AED
- BLS and ALS procedures per protocol
- No pulses or vitals



Case 5 Initial: No pulses



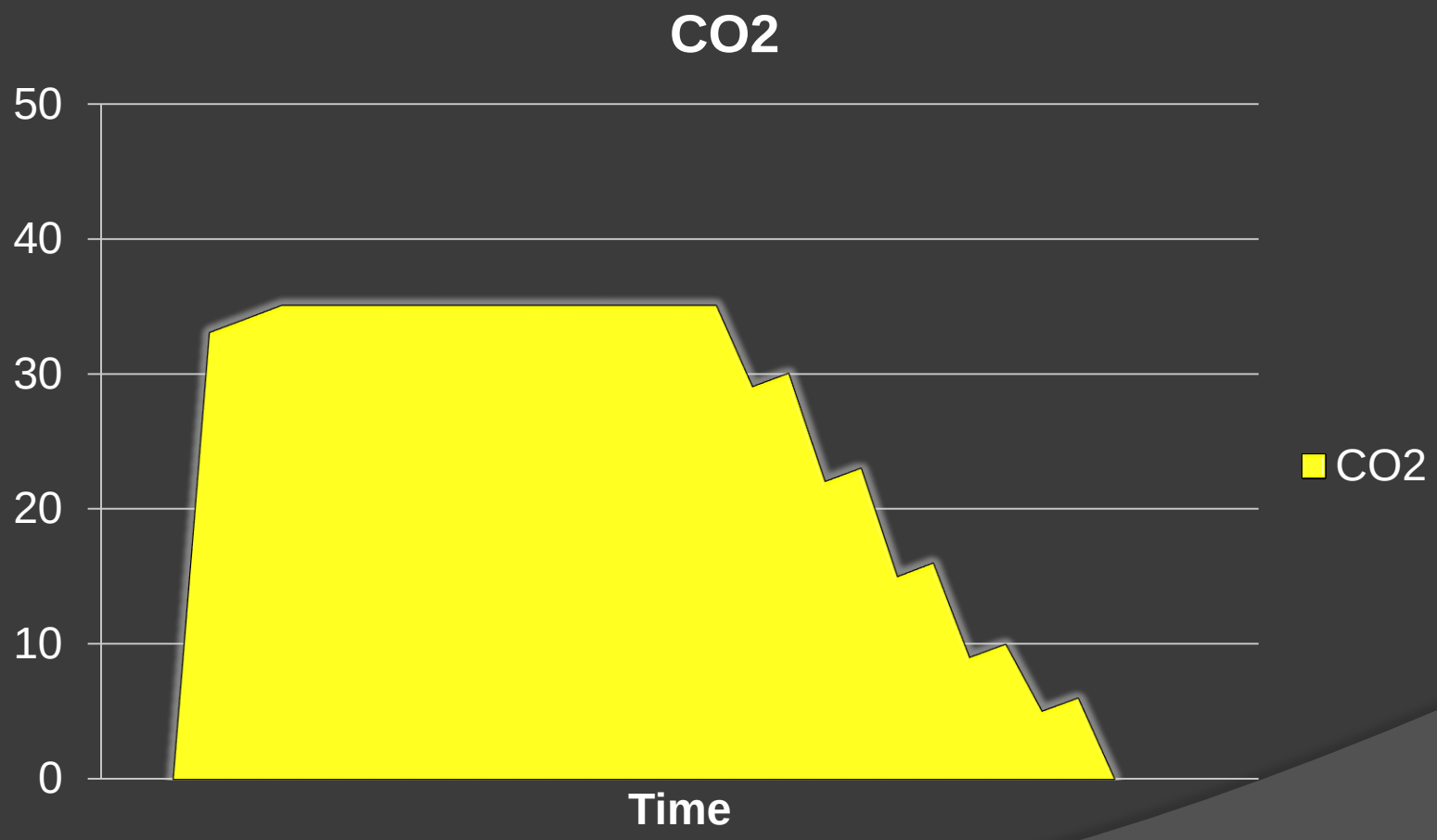
Case 5: No pulses



Cardiac Arrest and CO2

- In cardiopulmonary arrest
  - CO2 levels in blood stream increase
  - Exhaled CO2 levels decrease due to low flow states
    - No ventilation, no circulation of blood
    - No perfusion
  - Cambridge journal Article
- Return of Spontaneous Circulation (ROSC)
  - ***Spike in EtCO2 after trend of low levels***

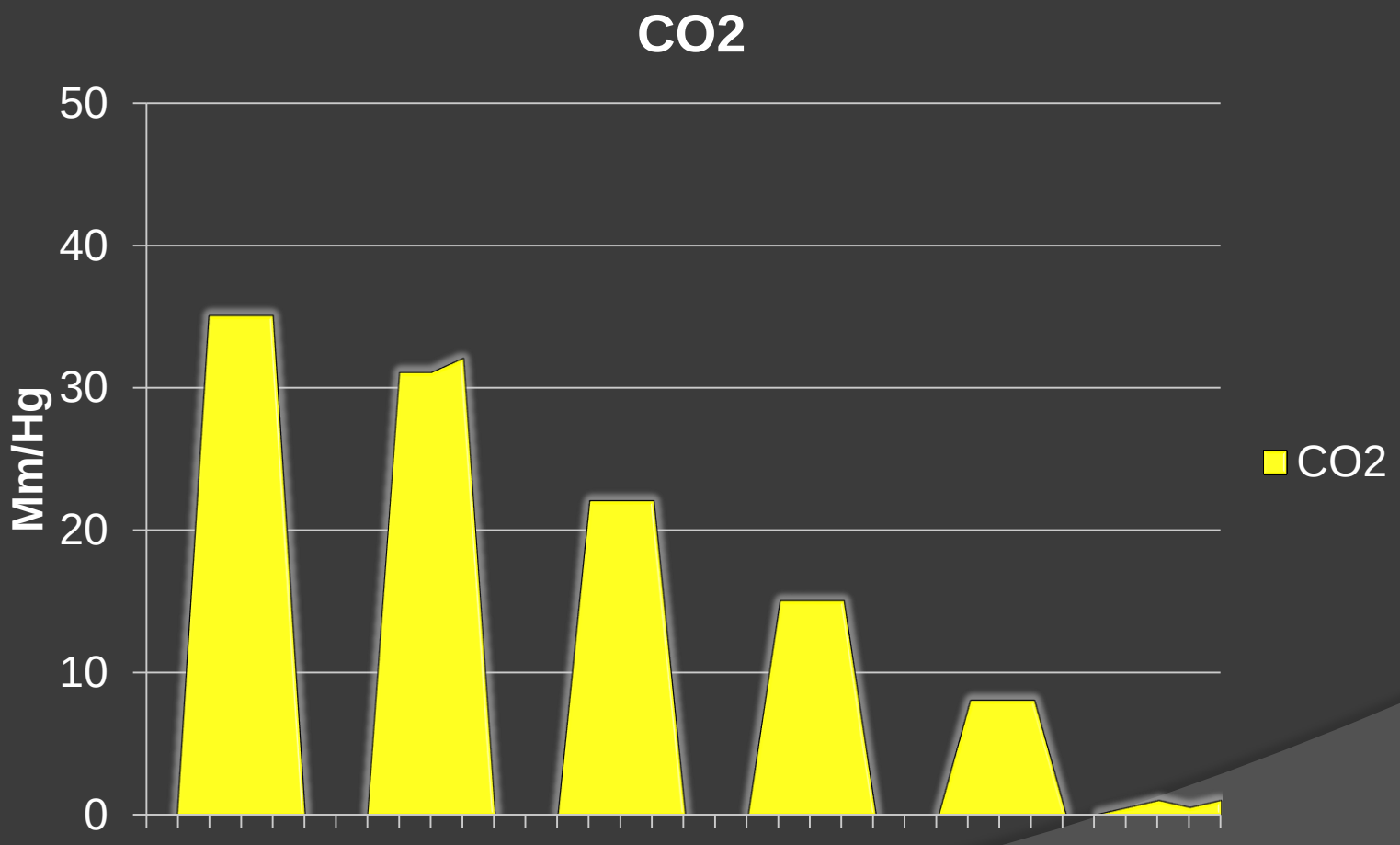
Case 5 Variant



Case 6

- 48 year old COPD
- Cyanotic, lethargic
- Vitals: HR: 131 A-fib, BP: 158/100, RR: 32, SaO2 on NRB: 90%
- After intubation, EtCO2 35mmHg
- Patient beginning to wake, and move head

Case 6



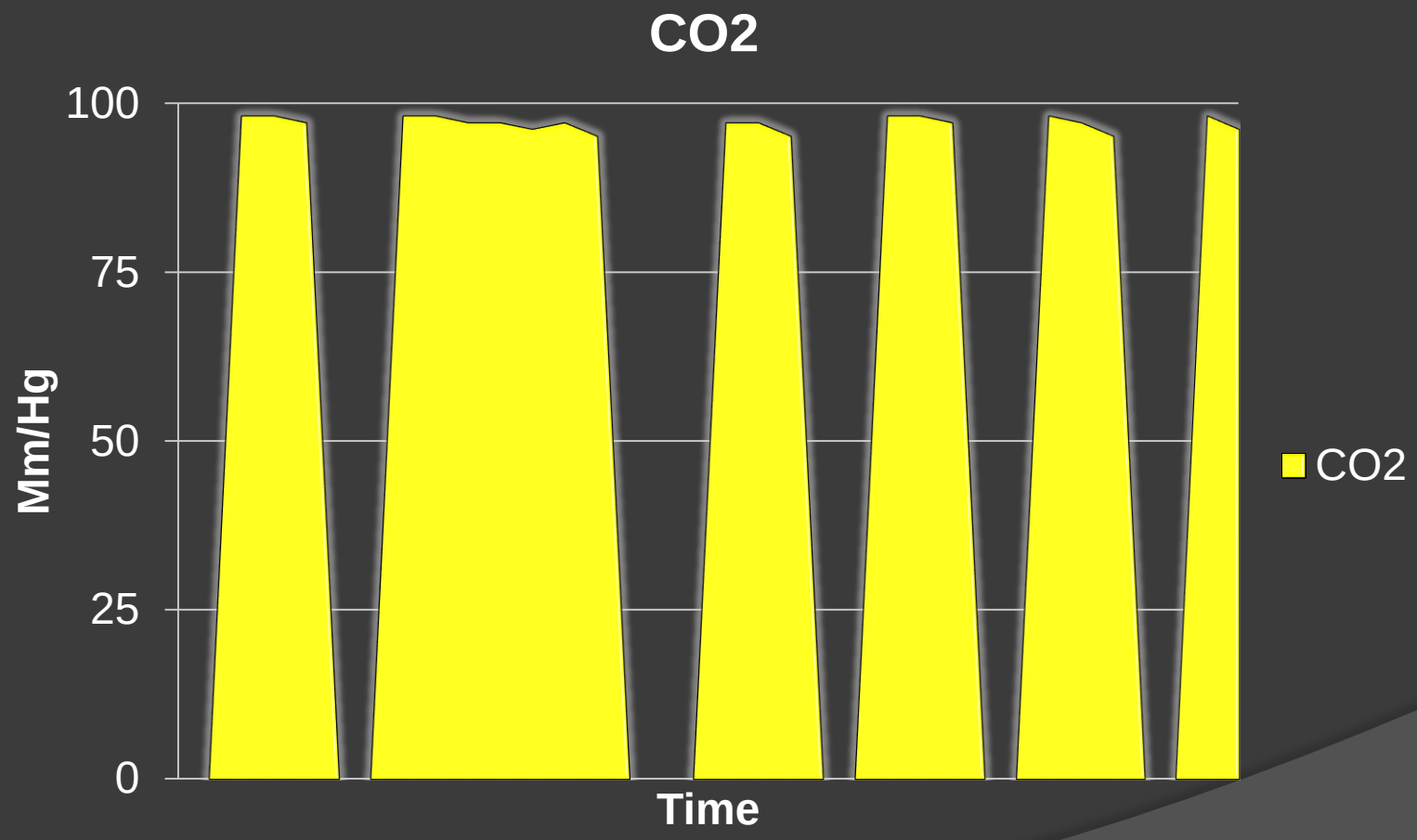
Case 7

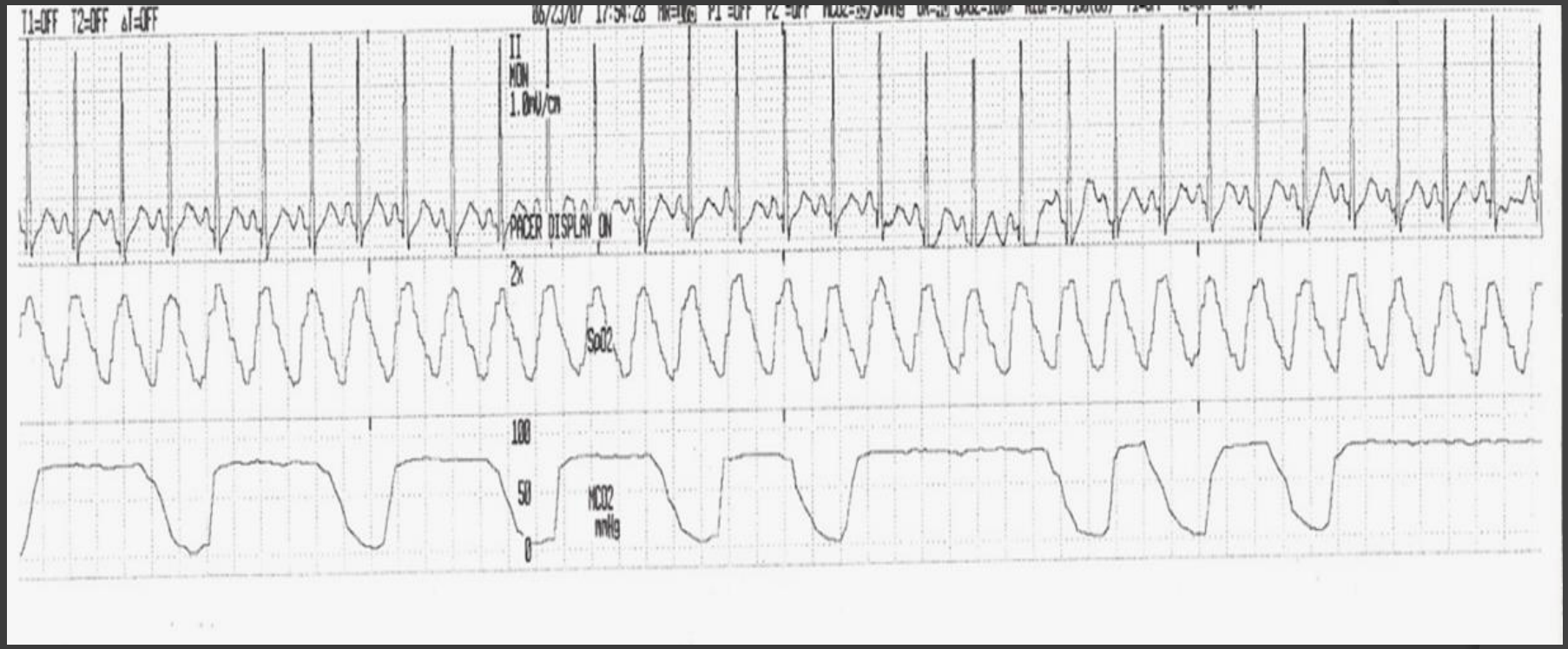
- 2 year old female with new onset seizures
- Inter-facility transport for tertiary care
- Intubated / Ventilated by BVM
  - 4.5 ET uncuffed
- Vitals: HR 160, BP 84/40, Ventilated at rate of 36, SaO2 100%, Temp: 103
- Ventilator: FiO2 100%, PEEP 5, initial I:E 1:2.7

Case 7

- Capnography
  - Initial level: 98mm/Hg
  - Shape: elevated box shape, irregular respiratory pattern at rate of 36
- What are your actions?
  - Increase rate?
  - Change I:E ratio?
  - ET problem
- How might etiology change treatment?
  - Asthma
  - Trauma

Case 7

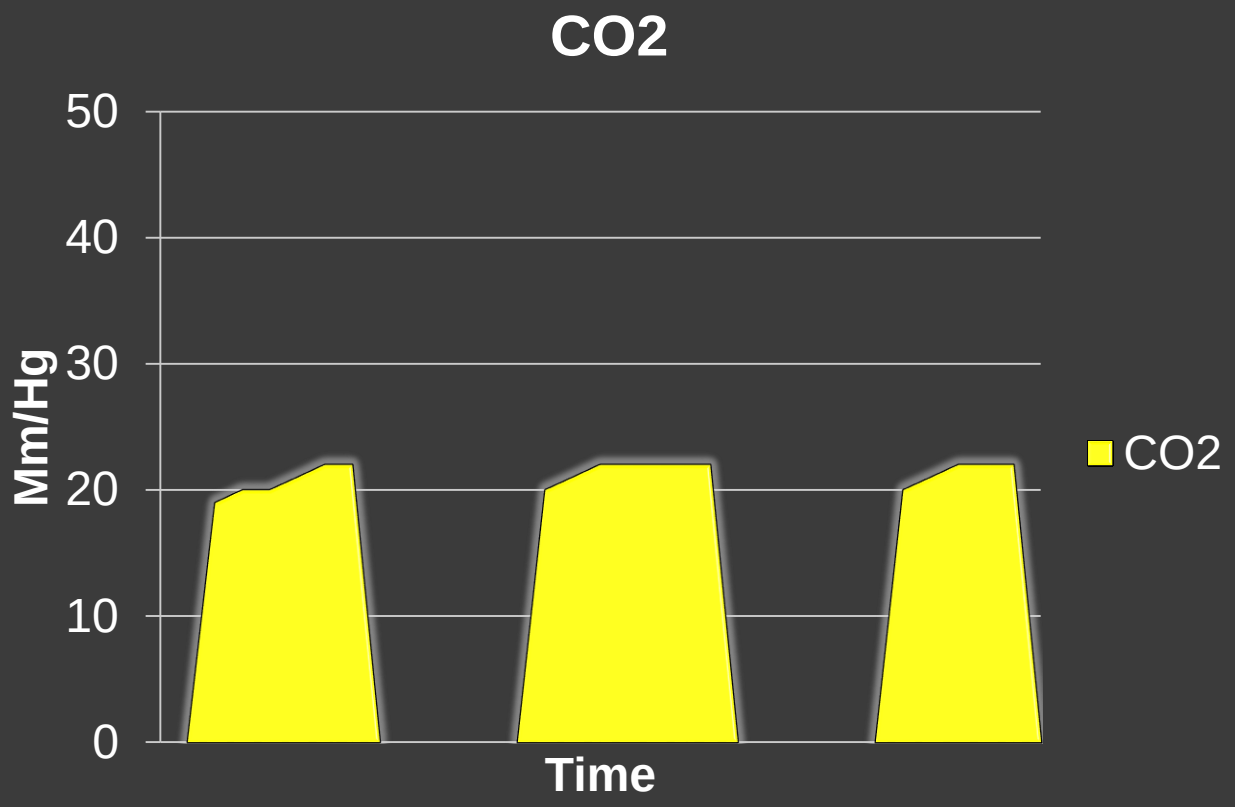



T1=OFF T2=OFF ΔT=OFF
II
MON
1.0mV/cm
PACER DISPLAY ON
2x
SpO2
100
50
0
mmHg

Case 8

- Interfacility transport:
  - 56 year old male admitted with “fever”
  - Diagnosed with “sepsis:
- PMH: ESRD, IDDM, CAD, CHF
- Lethargic, GCS 12,
- Vitals: 84/60. HR 130, respirations 10 irregular
- Intubated electively for transport
- Initial EtCO2: 21mmg/Hg

Case 8



Case 8

- Capnography:
  - Reason for Low EtCO2?
- What are your corrective actions?
  - Decrease ventilation rate?
  - Fluids?
  - Pressors?
  - Blood products?

Case 8

- Consider:
  - BP of 140/90, HR 110, RR 28
- EtCO2 of 28mHg
- Respiratory alkalosis as an initial compensation for metabolic acidosis
  - Capnography considered a potential triage tool.

Case 9

- Patient with isolated extremity entrapment
- Awake, oriented, agitated and in severe pain, 10/10
  - BP 150/70, HR 118, R 20, SaO2 100%
- Movement of extremity increases agitation and pain
- Do you have a sedation protocol?

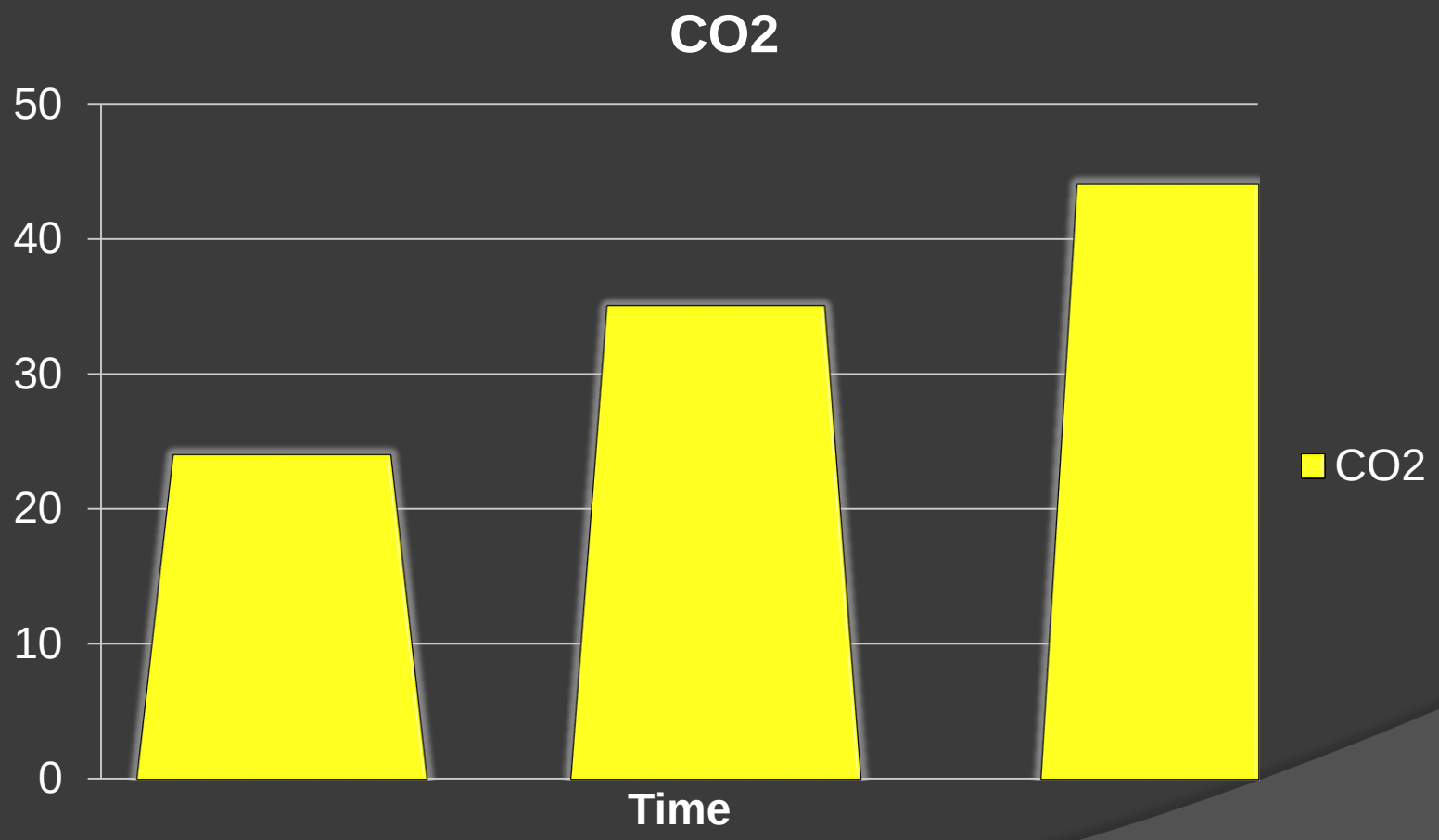
Case 9

- Sedation:
  - Different levels based on need
- EMS sedation considerations
  - Extrication
  - Cardioversion
  - Psychiatric/Behavior crisis

Case 9

- Goal of Sedation: induce lowered state of consciousness to tolerate procedures while maintaining their own cardiorespiratory functions
- Hospital: often involves MORE than 1 medication
- All those we warn you about….

Case 9

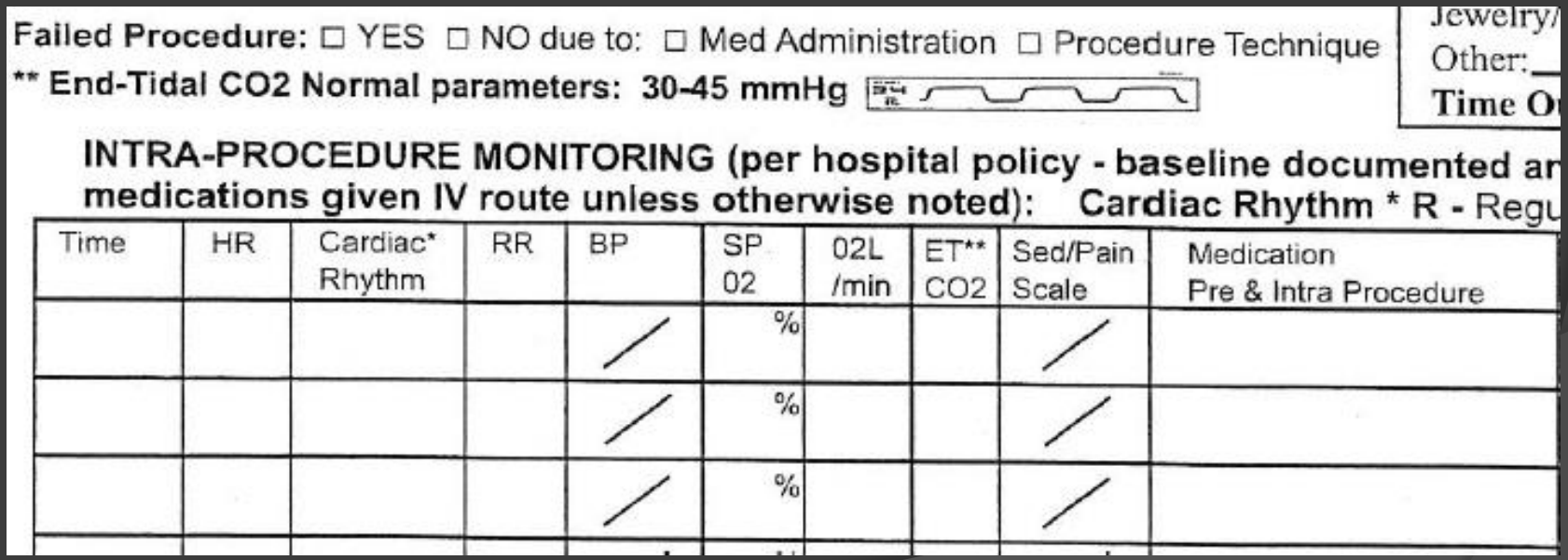


Case 9

- Conscious Sedation Monitoring parameter
  - What is required?
- What do we need to know while monitoring the patient?
  - Apnea?
  - De-saturation
  - Agitation?

Case 9: Sedation

- Quality of ventilation
- Detection of Apnea
- Predictor of Compromise



Failed Procedure: ☐ YES ☐ NO due to: ☐ Med Administration ☐ Procedure Technique

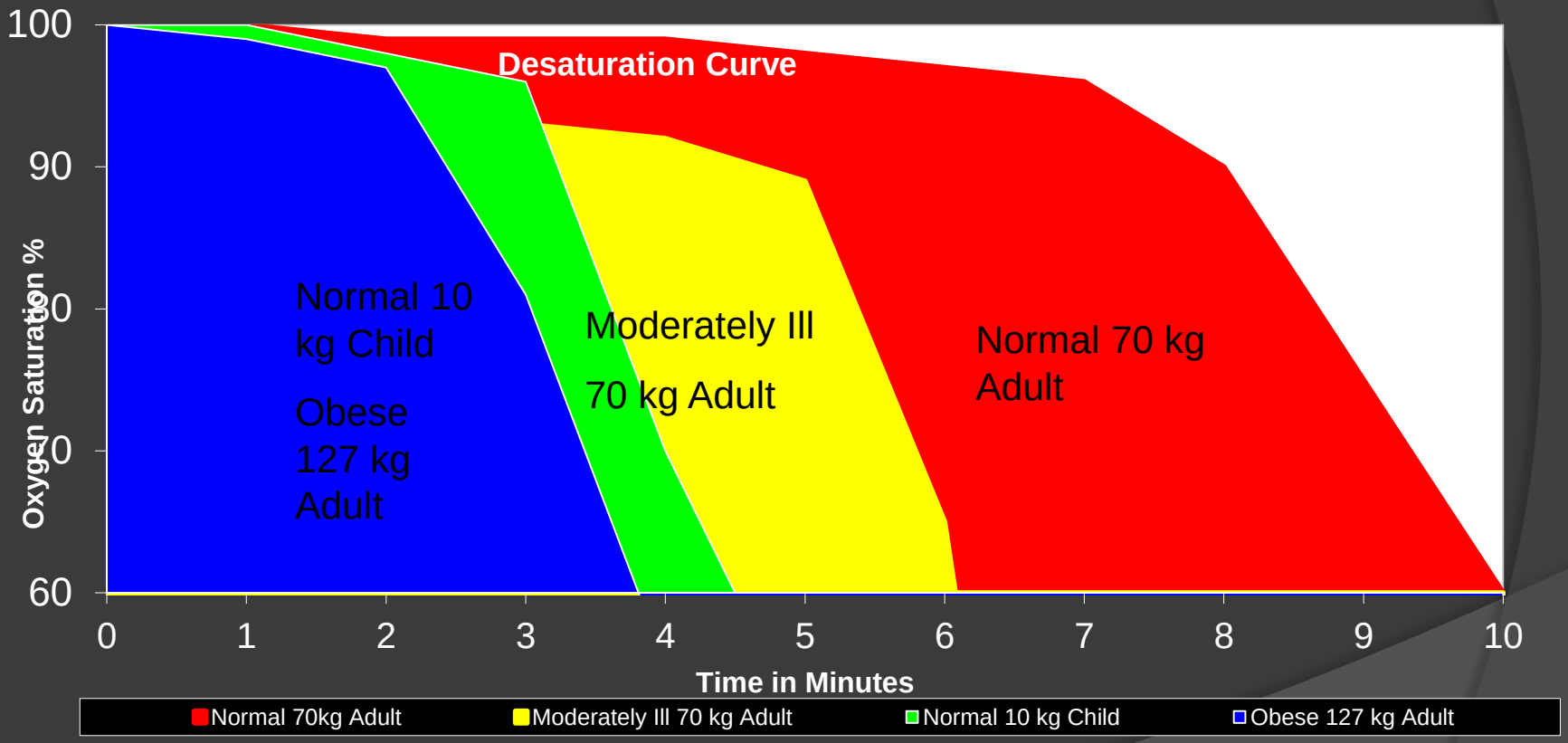
** End-Tidal CO2 Normal parameters: 30-45 mmHg

Jewelry/
Other:
Time O

INTRA-PROCEDURE MONITORING (per hospital policy - baseline documented ar
medications given IV route unless otherwise noted): Cardiac Rhythm * R - Regu

Time	HR	Cardiac* Rhythm	RR	BP	SP 02	02L /min	ET** CO2	Sed/Pain Scale	Medication Pre & Intra Procedure
				/	%			/	
				/	%			/	
				/	%			/	

De-saturation curve



From **Manual of Emergency Airway Management**, 2nd Edition, page 25

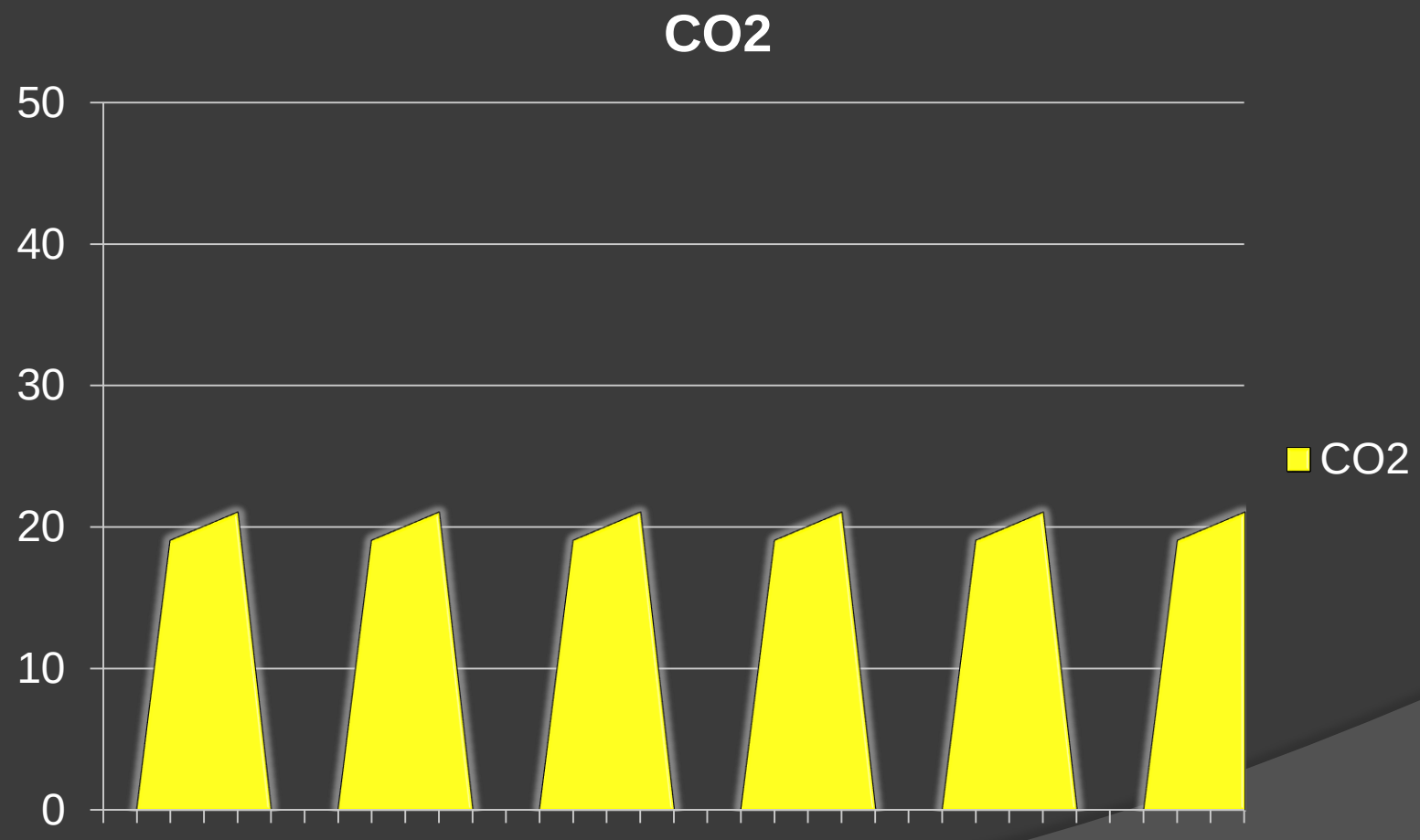
Literature

- ENA Emergency Nursing Resources
  - Level B: Moderate clinical certainty
  - Likely Beneficial
    - Proehl, J., Arruda, T., Crowley, M., Egging, D., Walker-Cillo, g., Papa, A., . . . Walsh, J. (2011, November). Emergency Nursing Resource: The use of Capnography during Procedural Sedation/Analgesia in the Emergency Department. *Journal of Emergency Nursing, 37*(6), 533-536.
    - Lightdale, J. R., Goldman, D. A., Feldman, H. A., Newburg, A. R., DiNardo, J. A., & Fox, V. L. (2006, May 15). Microstream Capnography Improves Patient Monitoring During Moderate Sedation. *Pediatrics, 117*(e1170). Retrieved October 5, 2013

Case 10

- 21 year old male c/c chest pains
- Sudden onset
- Stabbing, non-radiating, 10/10
- Tingling in his fingers

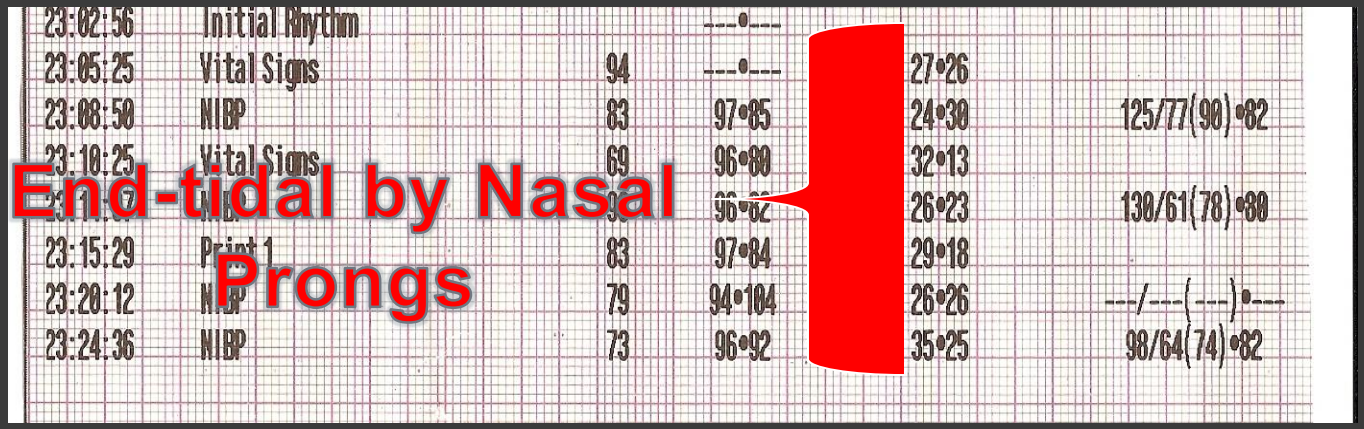
Case 10

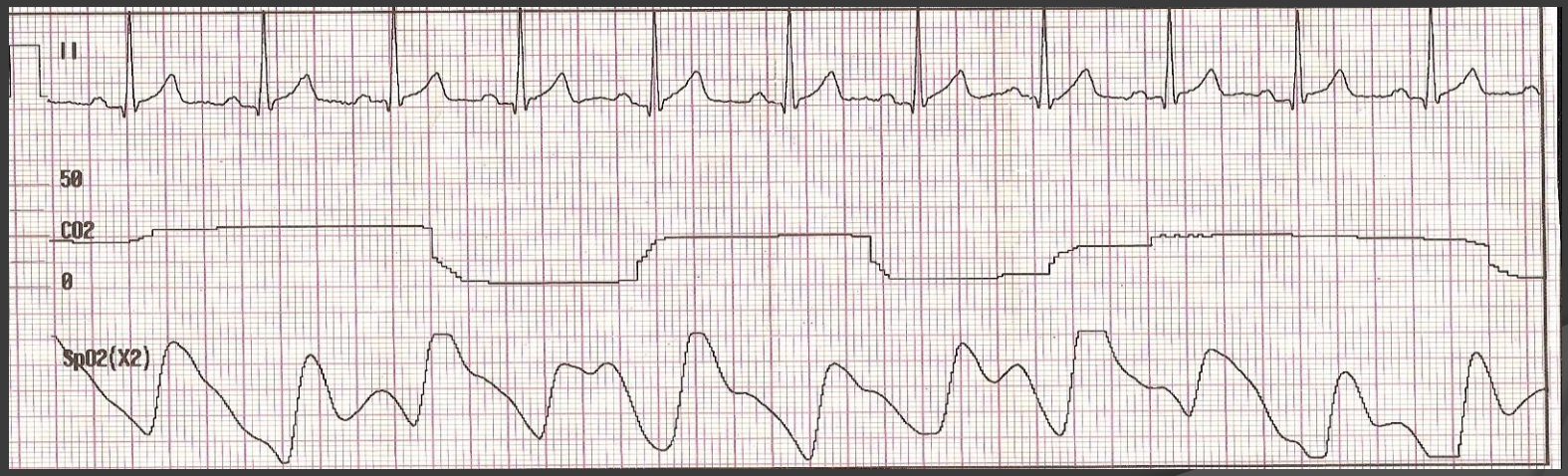


Reality


/9/2009 19:03:47 PULSE 138 NBP 156/135 (141) %Sp02 99 EtC02 18 IMC02 2 AWRR 27 25 mm/sec
10-144 11/9/2009 19:03:58
CHART NO. 804700

Case 10

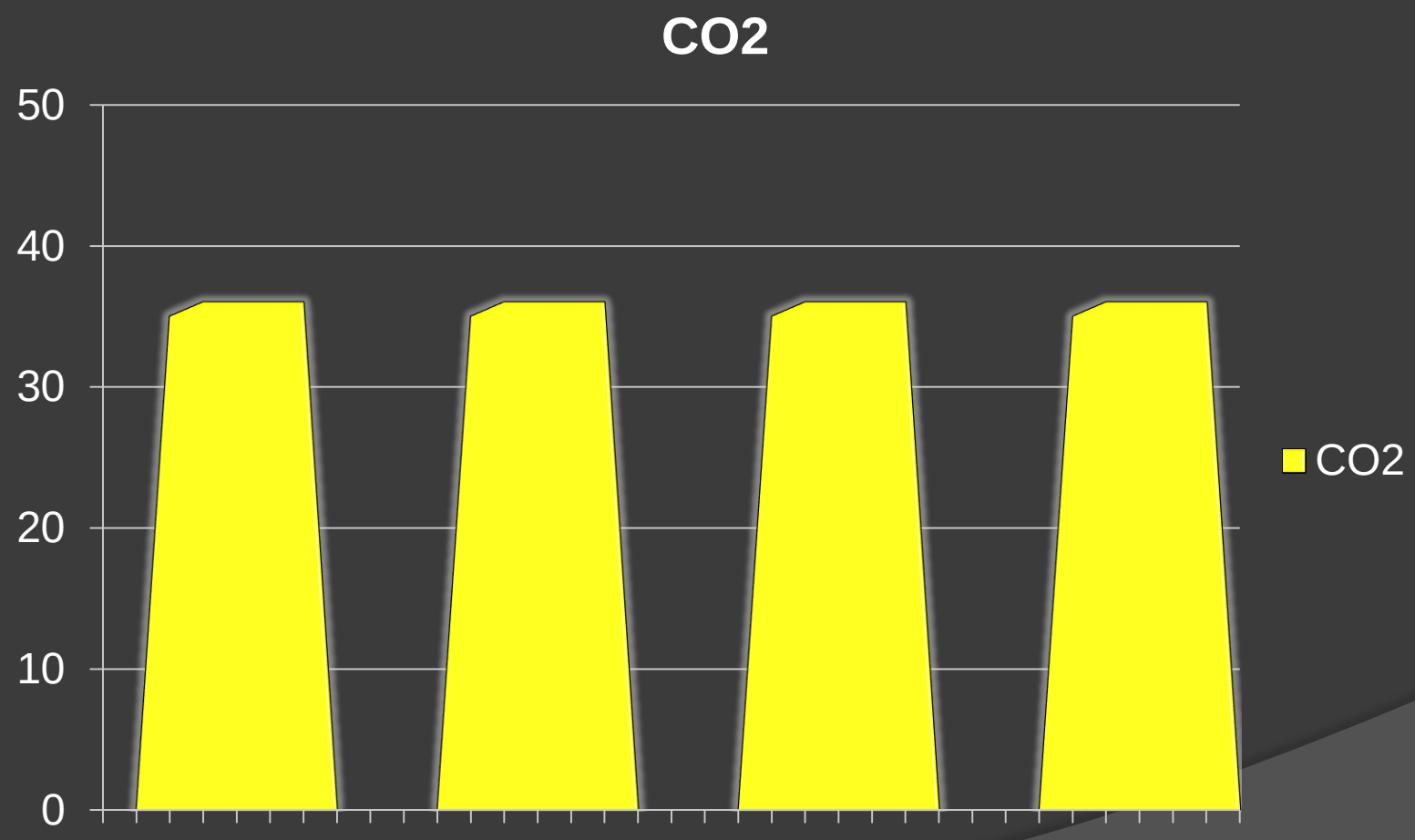

23:02:56 Initial Rhythm ---•---
23:05:25 Vital Signs 94 ---•--- 27•26
23:08:50 NIBP 83 97•85 24•30 125/77(90)•82
23:10:25 Vital Signs 69 96•80 32•13
23:15:29 Print 1 83 97•84 29•18
23:20:12 NIBP 79 94•104 26•26 ---/---(---)•---
23:24:36 NIBP 73 96•92 35•25 98/64(74)•82
End-tidal by Nasal Prongs


II
50
CO2
0
SpO2(X2)

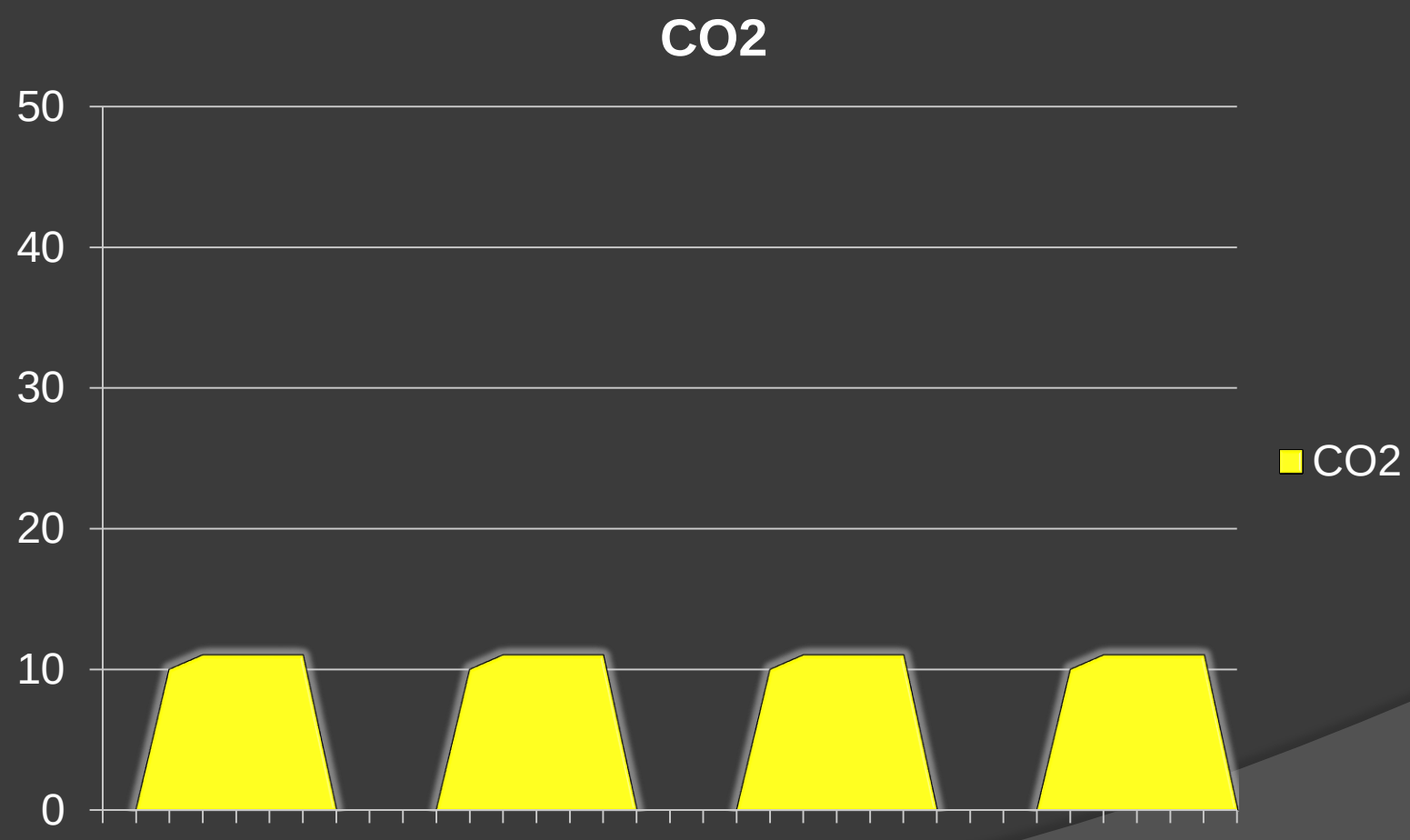
Case 11

- Female trauma patient
  - Unrestrained driver with steering wheel deformity; found under dash after airbag deployed
  - Pattern of injury??
- Intubated successfully
  - Confirmed by waveform sedated and paralyzed
- 25 minute flight to Trauma Center

Case 11: Cruising Along



Case 11: Sudden Change!



Case 12

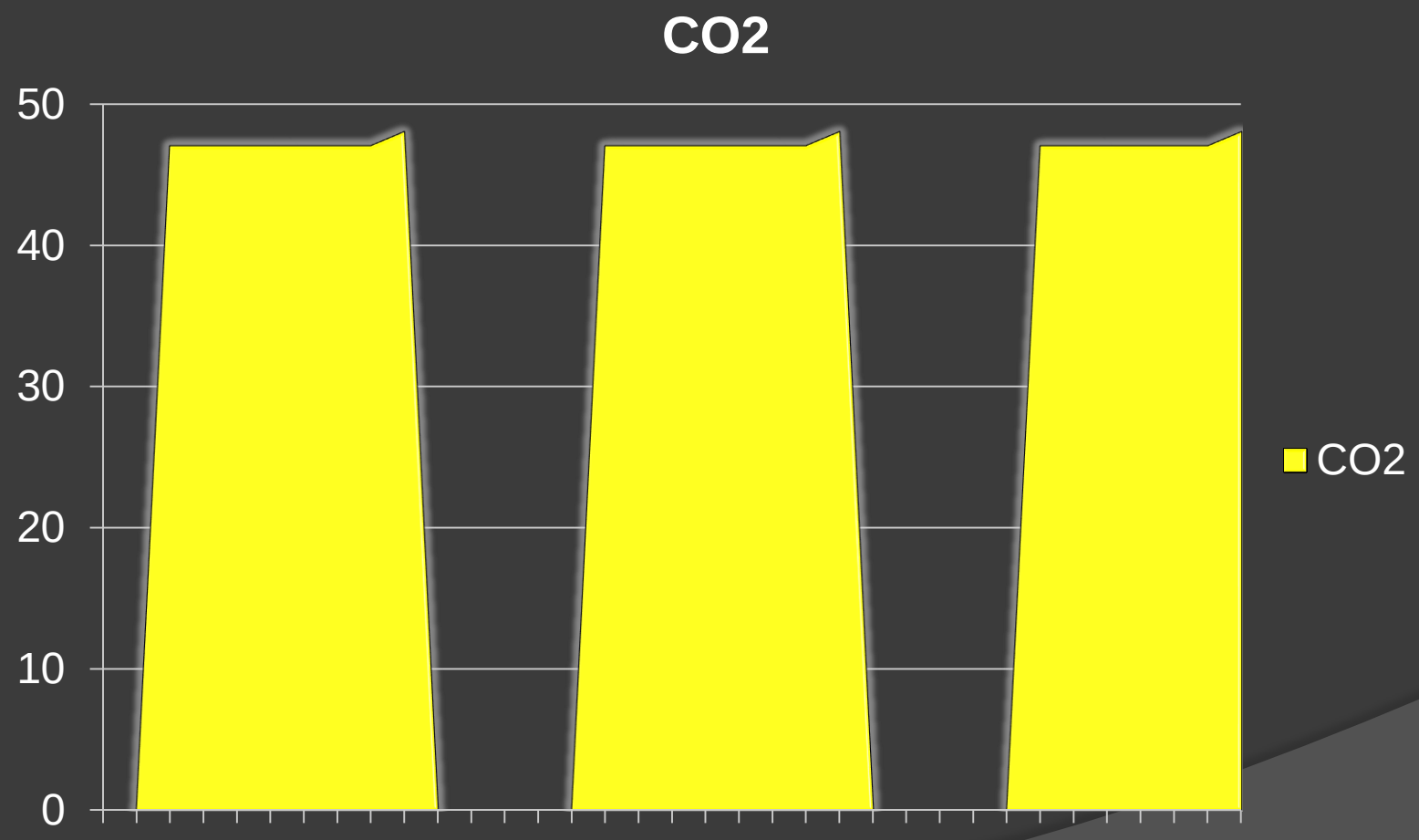
- 57 year old obese male with spinal trauma
  - Fell forward, hyper-flexion of neck
  - Confirmed C5, C6 fractures
- CNS Intact-full movement
  - GCS of 9T (14 if not intubated)
- Intubated: and we did not know how
  - Sedation/fiberoptic ETI by anesthesia
- On T-piece, NOT VENTILATED breathing on his own

Case 12

- Considerations:
  - Community hospital to Level 1 trauma Center
  - Patient obese: 280 pounds
  - Aircraft: EC135
  - No existing ventilator settings; crew discretion on “optimal”
  - Difficult airway on multiple dimensions
    - Confirmed by CXR prior to movement

Case 12: Volume Ventilation

Case 12: Pressure Ventilation



Case 12

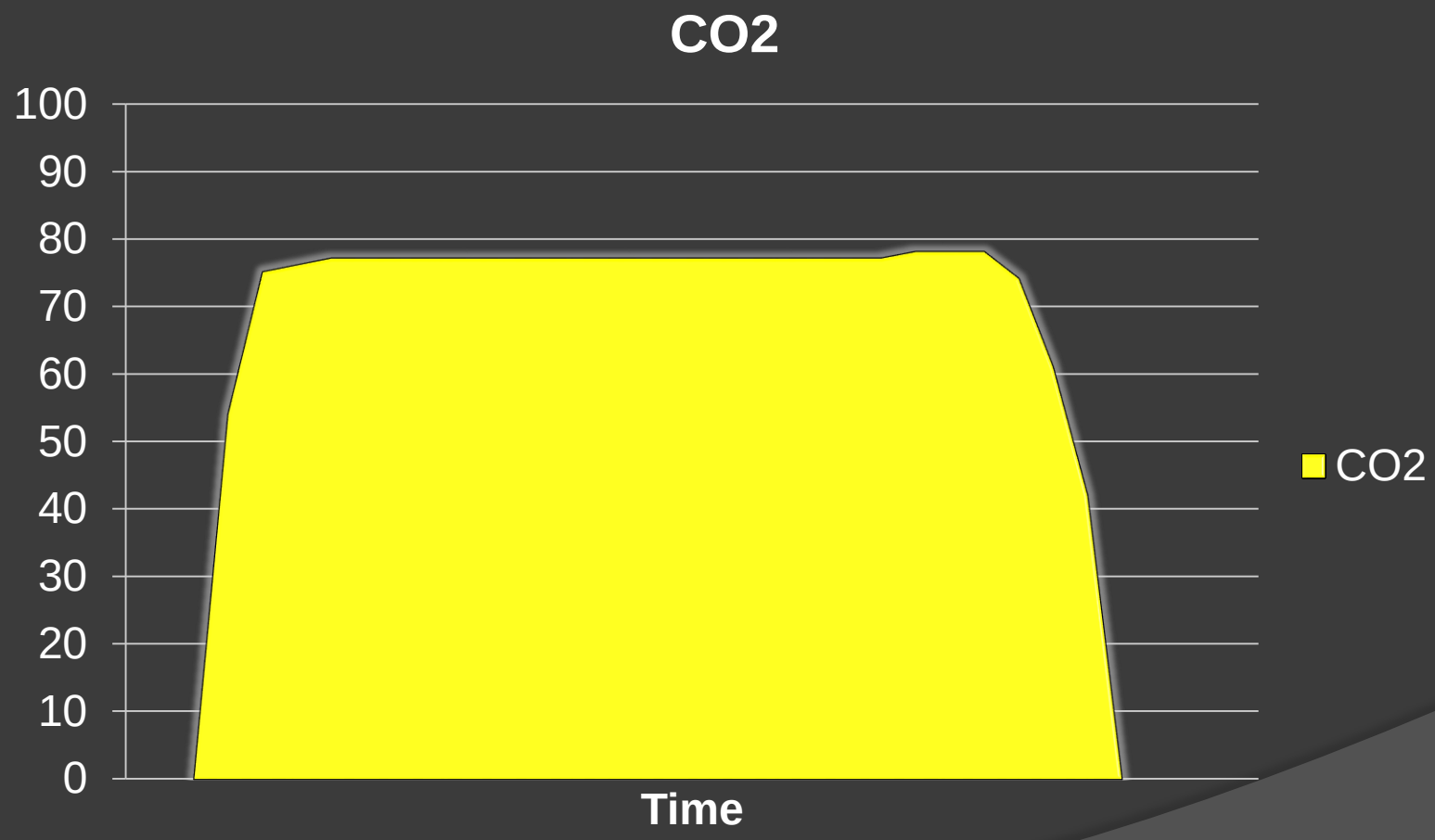
- Pressure versus volume ventilation
  - Pressure Control 24, FiO2 100%, Rate 12, Assist Control with PSV
  - Switch to BVM after desaturation
- Sedation, paralysis, pain control
- How might a different airframe change management? Or ground unit?
  - Bell 407 vs. 412
  - EC130 vs EC 135/145

Case 12

- Physical restriction of breathing
  - Burns
  - COPD
  - Trauma
  - Surgical

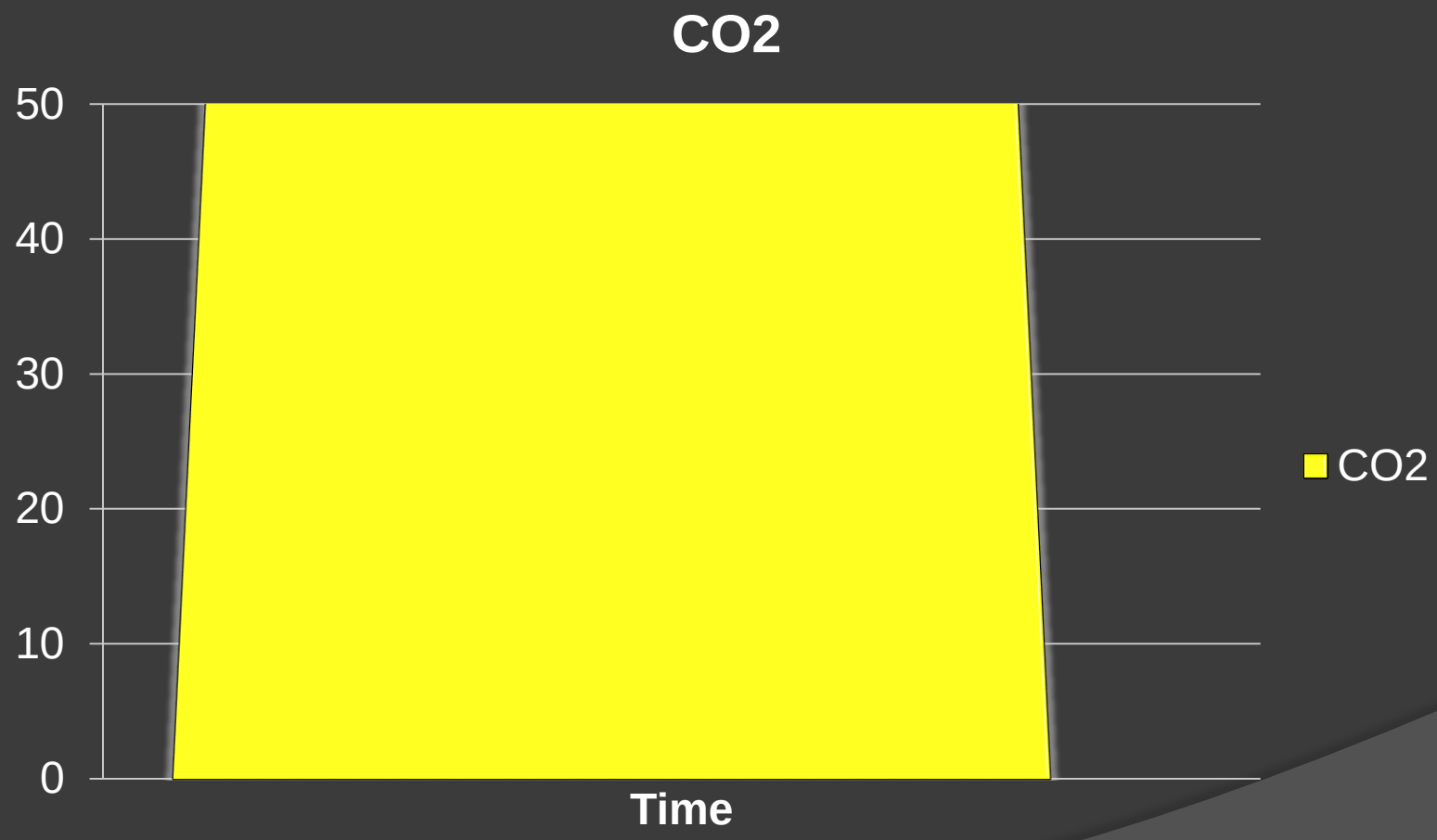
Case 13

- 55 year old male overdose
  - History of treatment for opioid abuse
- Progressive respiratory depression
- Noted multiple “Suboxone” patches on arms.
- EMS summoned when level of consciousness deteriorated


CO2
100
90
80
70
60
50
40
30
20
10
0
Time
CO2

Case 14

- 24 y/o patient in head on MVC
- Altered LOC, combative, signs of head injury
- RSI clinical course
  - Etomidate 0.3 mg/kg
  - Succinylcholine 1.5 mg/kg
- After paralytic, patient developed trismus and rigidity
- Unable to intubate, but can ventilate with oral airway in place
  - Unable to open mouth to place King LtD


CO2
50
40
30
20
10
0
Time
CO2

Case 14 Malignant Hyperthermia

- Life Threatening
- Hypermetabolic state in patient's with hereditary skeletal muscle defect
  - Genetic predisposition 1:10000
  - Clinical Incidence 1:30000
- Depolarizing muscle relaxants (Succinylcholine) and anesthetic gases cause raise in myoplastic calcium

Malignant Hyperthermia: Signs and Symptoms

- Hypercarbia: most sensitive indicator in intubated patient
- Tachycardia
- Tachypnea
- Temperature elevation
- Hypertension
- Dysrhythmias
- Acidosis
- Hypoxia
- Hyperkalemia
- Skeletal muscle rigidity
- Myoglobinuria

MH Management

- Get help!
- Hyperventilate patient with 100% oxygen
- Cool patient
- Antidote is Dantrolene
  - Truly the only effective treatment
  - Operating rooms have an MH cart stocked with multiple bottles
- Prehospital considerations
  - Non-depolarizing paralytic
  - Benzodiazepines

Other Applications:

- Respiratory monitoring
  - Overdose/Ingestion
- Cardiac Output
  - LVAD

Documentation

- Initial CO2 waveform and numerical value
- Continuous tracing
  - Software dependent
- Turnover to receiving hospital personnel

Summary:

- Capnography is a TOOL
  - Does not substitute for good clinical skills
- Remember the BASICS
  - ABCs
- DO NOT OVERTHINK Capnography
  - Some cases will be difficult to figure out

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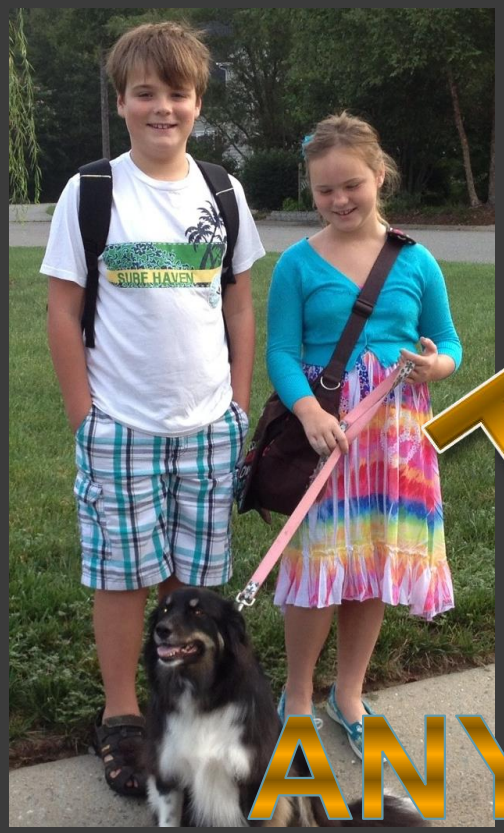

THANK YOU!!!!

ANY QUESTIONS?


Shamrock 5k
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