EMS Monitoring Devices: Tips and Pitfalls

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Monitors and machines

Assist with patient assessment BUT:

- Do NOT replace eyes-on/hands-on care
- Are just one piece of clinical judgment
- ALL have pitfalls/malfunctions/limitations
- Are more complex than ever

TREAT THE PATIENT, NOT THE MACHINE

$ETCO_2$ & CO_2 Waveform Capnography

- Used in ORs for decades, then ICUs, some EDs
  - Primary goal: prevent hypoxia by early identification of hypoventilation
  - Indicates adequacy of ventilation and perfusion
  - Verifies correct position of ETT or LMA
  - Standard of care for patients under general anesthesia
- Rapidly expanding use in EMS
- Quick poll of EMS Medical Directors:
  - Do you use waveform in ED or med practice?
  - How many use ETCO2 device in EMS?
    - Which—colorimetric, # Bars, # + waveform?

Alternative tube confirmation devices

$ETCO_2$ and Waveform for EMS

- Confirm placement of ETT, Combi, King
- Monitor tubes for dislodgement
  - After defibs or movement
  - Turnover of care at ED
- Determine status of patient perfusion
  - ROSC post arrest
  - Adequacy of CPR
  - Confirm if *dead* dead
- Documentation of all the above


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ETCO2 and Waveform in EMS

In non-arrest patients:

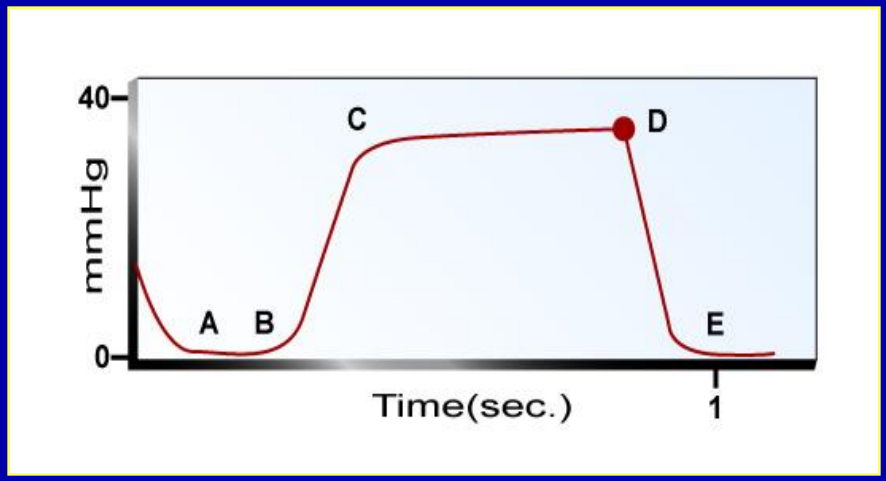
- **Determine status of patient ventilation**
  - **Apnea**
  - **Inadequate or excess ventilation**
- **Asthma/COPD vs. CHF**
- **Hyperglycemia vs. DKA**

Definitions for training

- "Tidal"—respiratory ebb and flow, like the tide
- End-tidal CO_2 is the # at <u>end</u> of expiration
- $ETCO_2$ vs. Serum PCO_2
- $ETCO_2$ vs. CO2 Waveform Capnography
- Capnometry vs. Capnography

Normal $ETCO_2$ & CO_2 Waveform

- Capnography shows CO_2 with ventilation
- Nl $\underline{ET}CO_2$ is ~ 5% (~ 35-37 mm Hg)
- Gradient ($PaCO_2$ to $ETCO_2$): 5-6 mm Hg
- $ETCO_2$ estimates $PaCO_2$ in pts with nl lungs



A = end of inhalation

B – D = exhalation

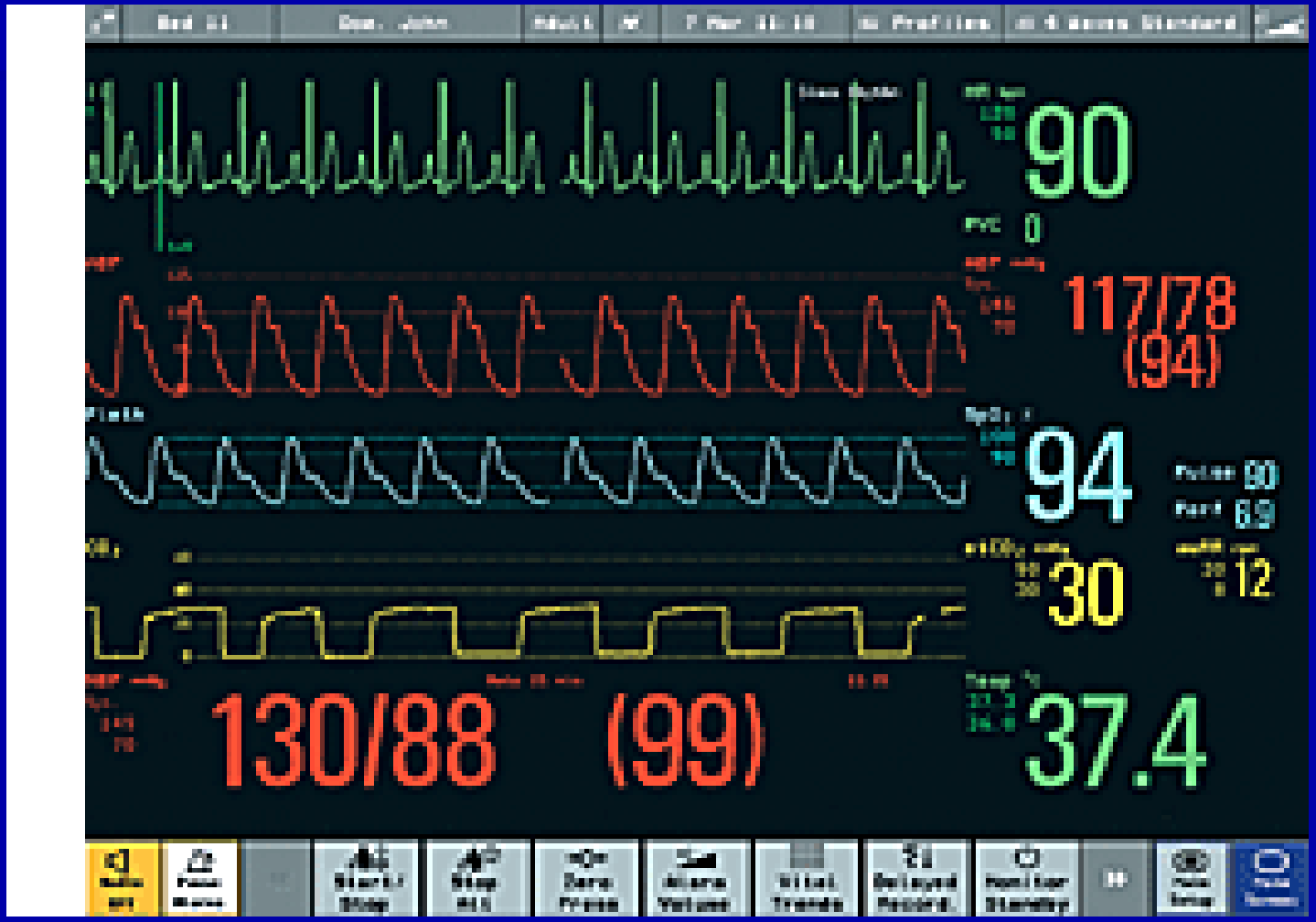
D = ETCO2

D – E = inhalation

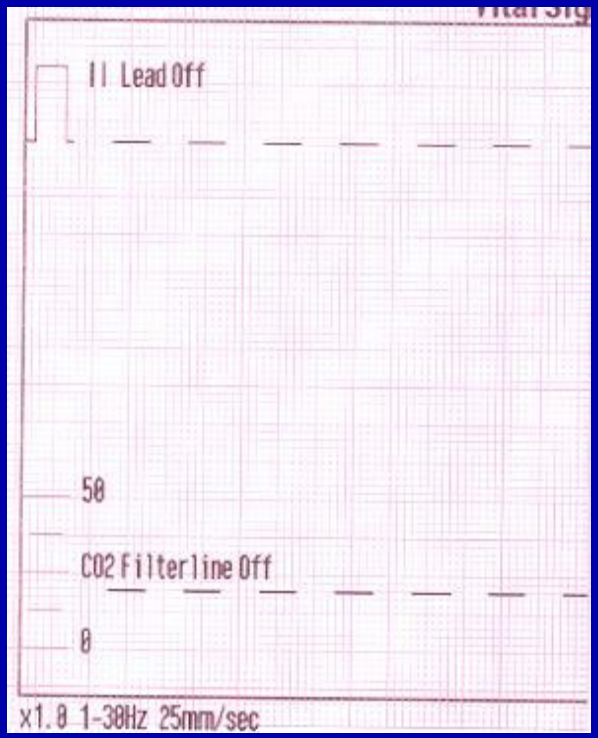
Learning ETCO2/Waveform

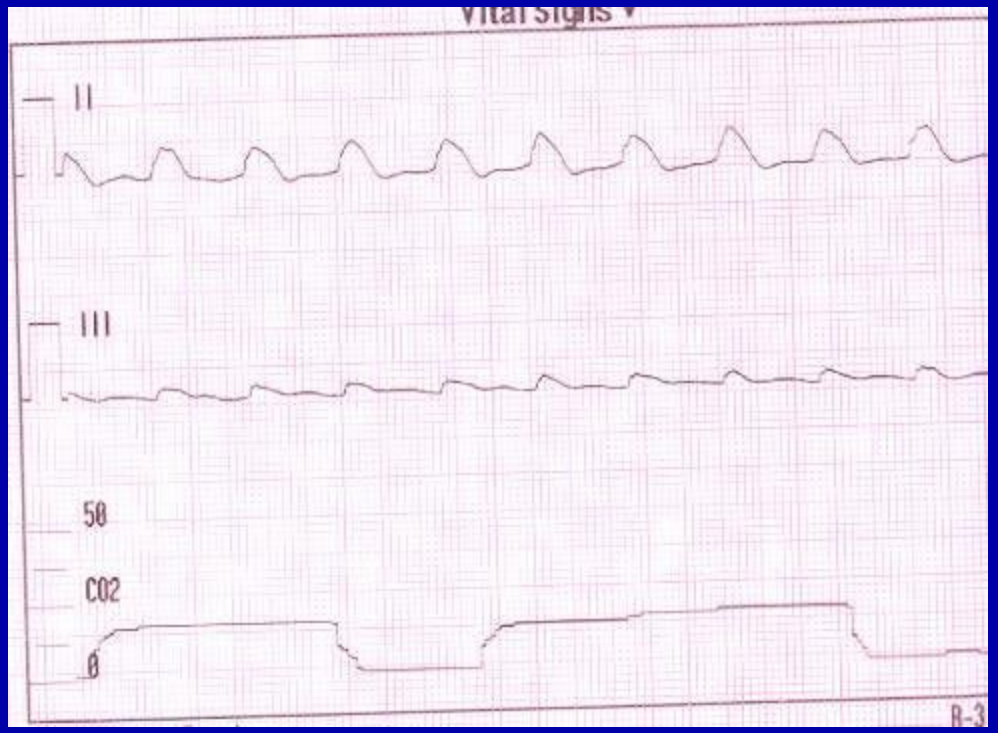
- TAKES TIME, PRACTICE, REFRESHER, QUESTIONS
- Tracings seem reversed at first (because of our concept of our breathing pattern)
- Practice concept by breathing in time with strip
- Easy if strips look "classic", but they often don't (field vs. OR)
- Must consider more than 1 cause for abnormality:
  - Ventilation vs. perfusion
  - Hypoperfusion v. hyperventilation v. tube above cords
  - Air trapping, dead space
  - Machine problem vs. Patient problem
- Trouble-shooting "weird" waveform is perhaps the hardest EMS skill to master

Tachypneic, Hyperventilating



Cardiac arrest, good ETT, should see
"CO2 initializing" then:

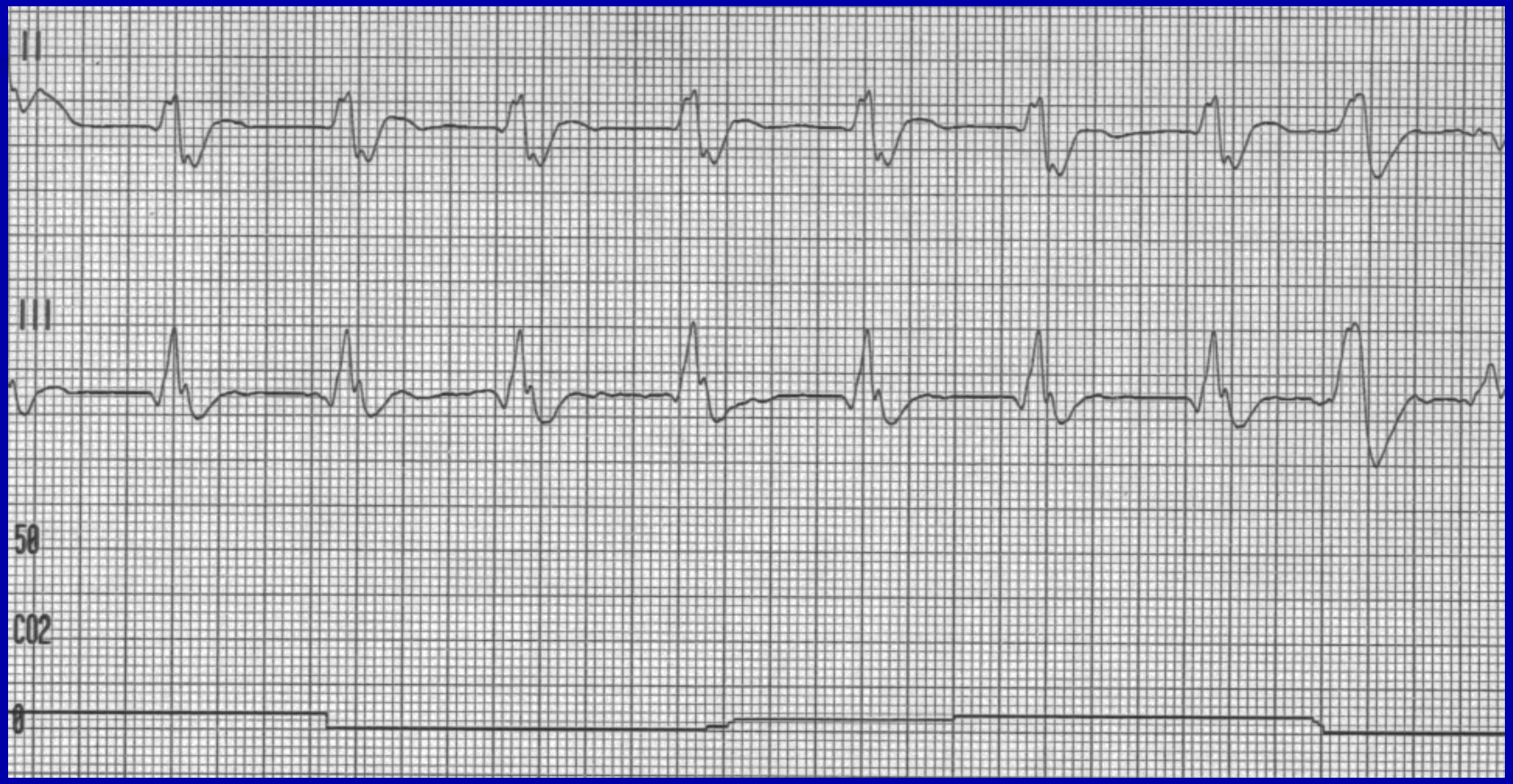




Arrest: ETT confirmed

ETT Confirmed, Low Perfusion

(slide from Dr. Baruch Krauss)



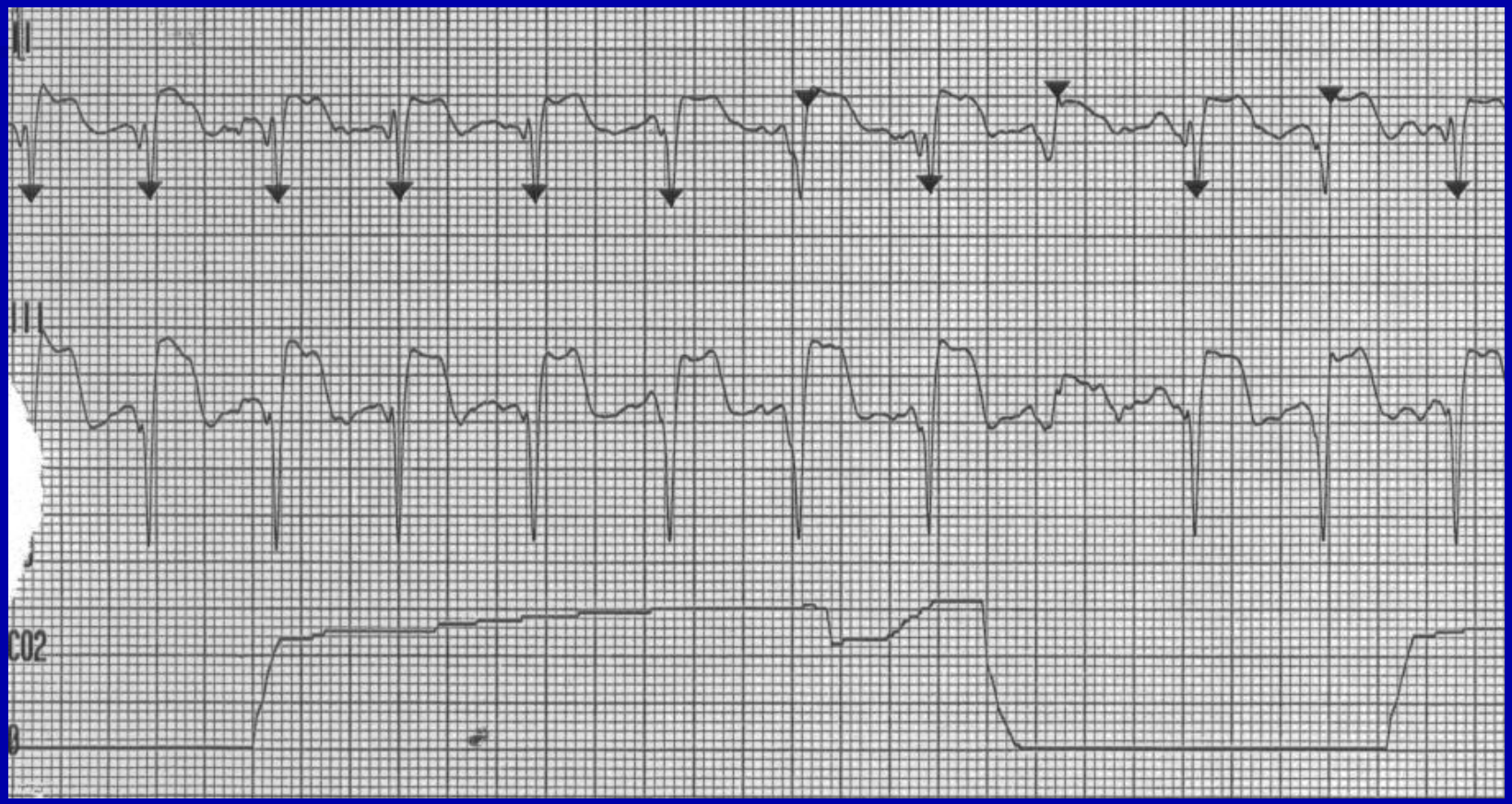
ETT good, VERY low perfusion

(slide from Dr. Krauss)

Ability to switch to lower amplitude range would help

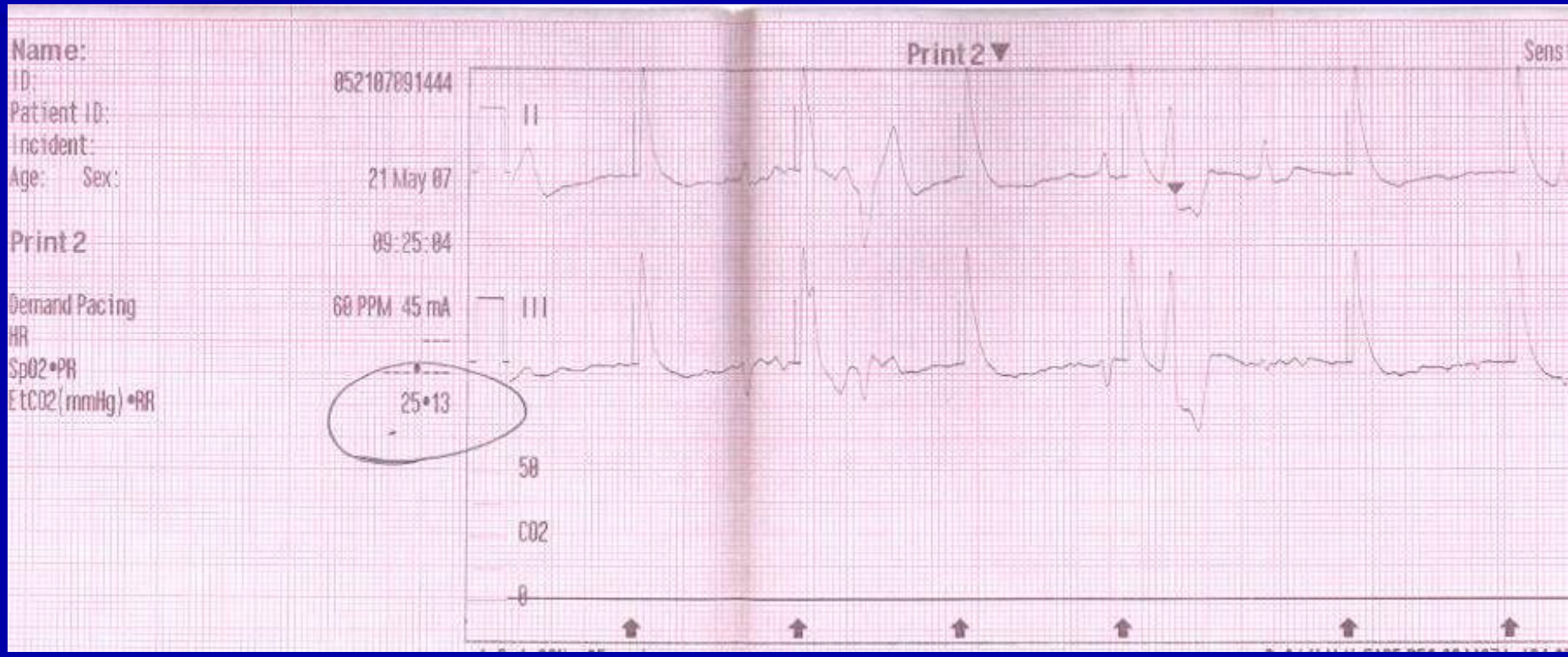
What we hope to see: ROSC!

(slide from Dr. Krauss)



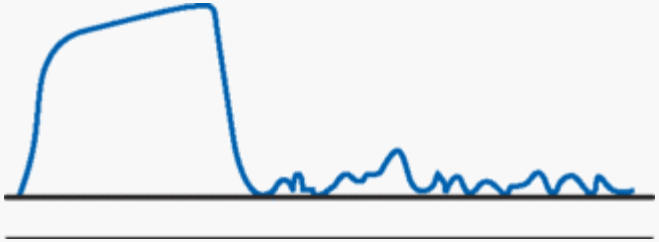
But, where is this ETT?

Flat straight solid black line at 0

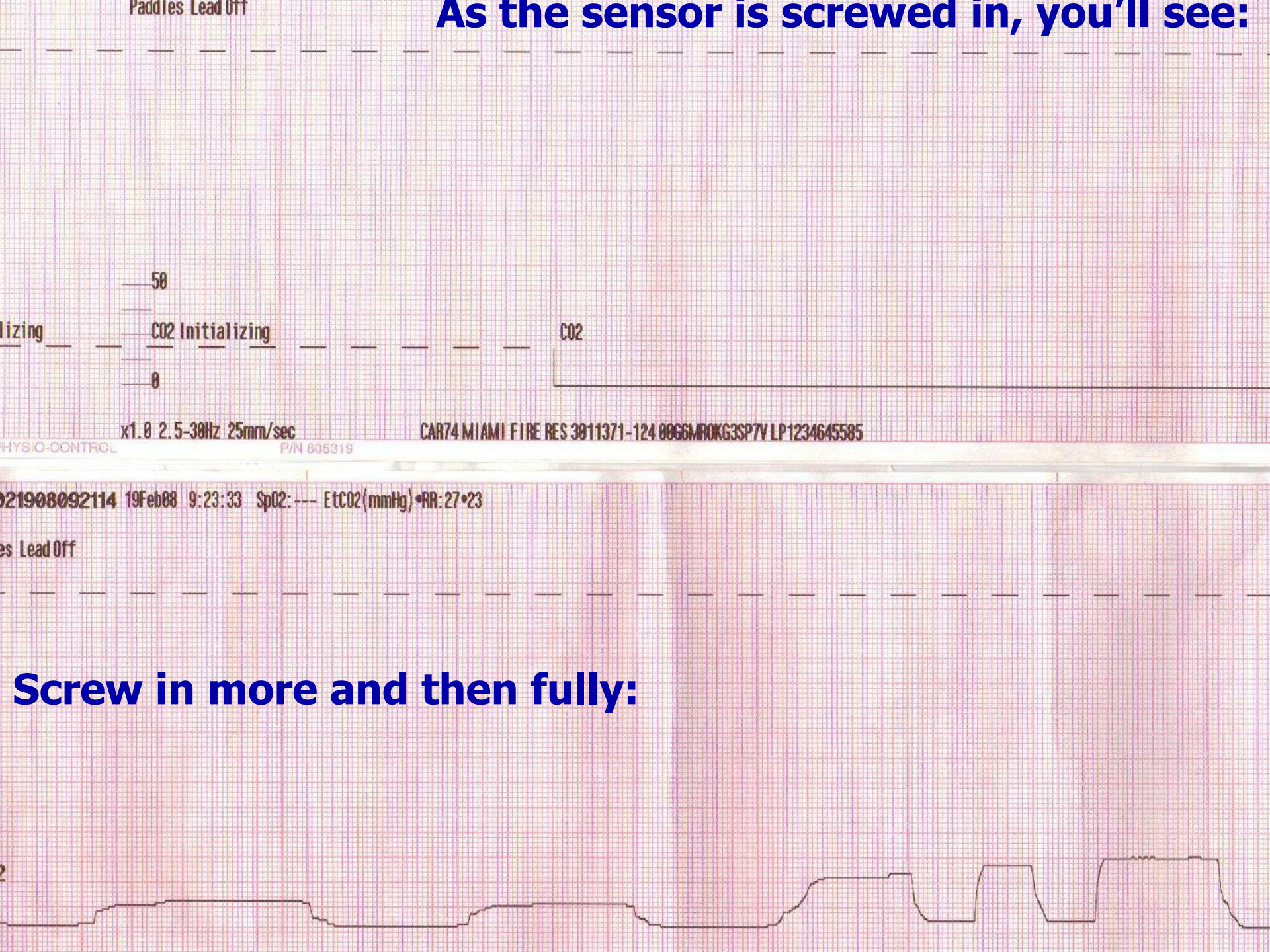


Good tube / Bad tube

One good waveform, then irreg/irreg/small



Tube in trachea, moved to esophagus



As the sensor is screwed in, you'll see:

Screw in more and then fully:

Playing with our LP 12

- Microstream sensor screws in 3 rotations
- When nearly tight, waveform may go from:
  - - - - to solid/flat/straight at zero (instead of pt tracing)
- Tighten a little, get a waveform & low plateau
- Tighten more, higher plateau
- TIGHTEN UNTIL WINGS HORIZONTAL = full waveform
- MIGHT LOOSEN during use—looks like tube moved
- (Tighten too far = broken sensor gold ring)

Straight flat solid black line at 0

Could be:

- ETT is NOT in trachea, or
- Good tube but sensor line is NOT fully connected, or
- Long dead

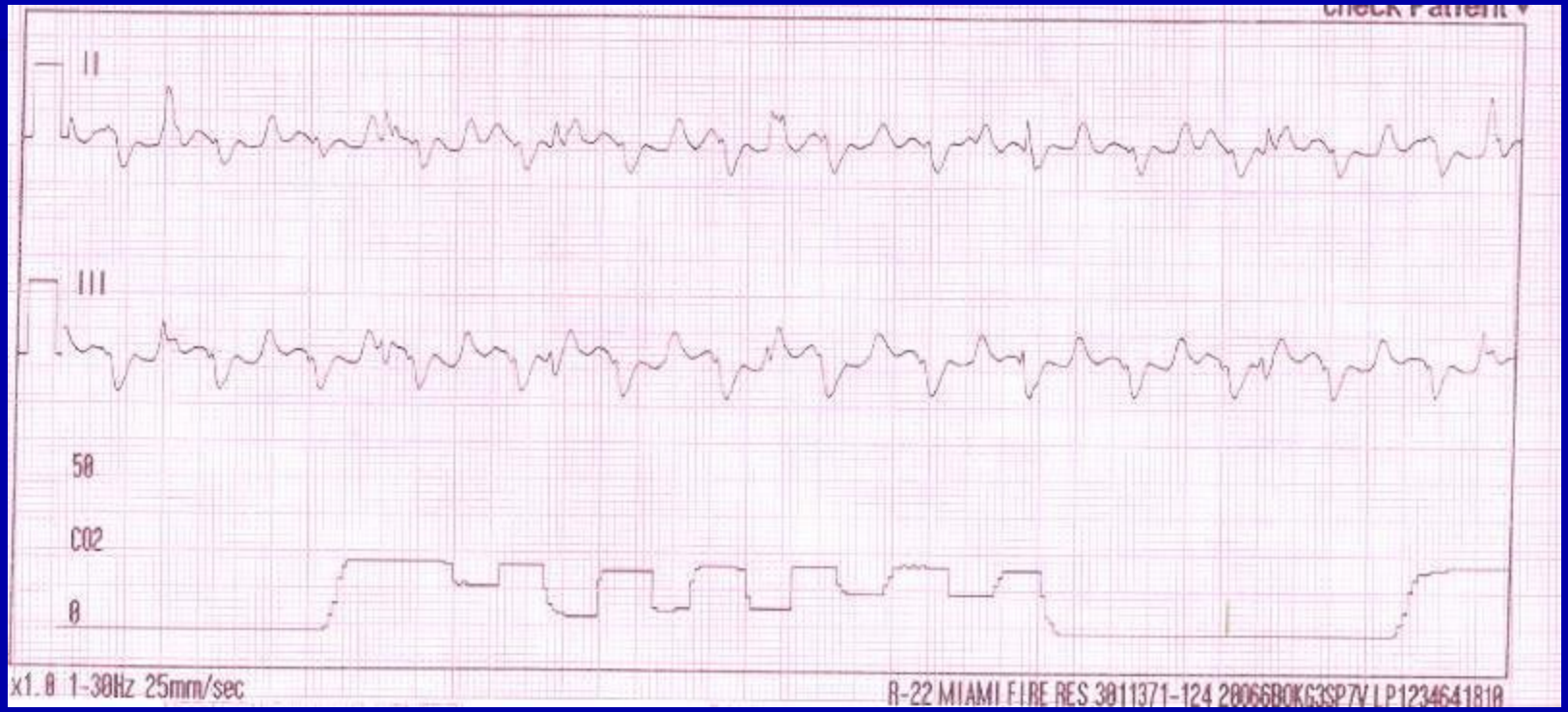
Actions:

- Tighten (wings horizontal) and bag 2-3 times watching for waveform or variation
- If none, immediately reconfirm ETT (& check CPR):
  - ★★Re-visualize with scope to see tube thru cords★★
  - Recheck all signs, patient status
  - Use a different device (colorimetric, EDD, etc)
- CONSIDER WHOLE PICTURE before replacing ETT
- DOCUMENT, DOCUMENT, DOCUMENT

More Trouble-shooting (LP12)

- Good waveform but low plateau:
  - Tube above the cords/hypopharynx, or
  - Sensor connection not quite tight, or
  - Perfusion poor
- Is it time to call the code (ET <10)?
  - Hard to read due to calibration scale 0-50
  - Be sure that sensor connection is good
- Did tube move after defib?
  - Tracing pauses after shock (or sensor now loose)
- Nasal sensor: variable readings
- Solid straight flat black line at high #= ????

Chest Compressions + $ETCO_2$



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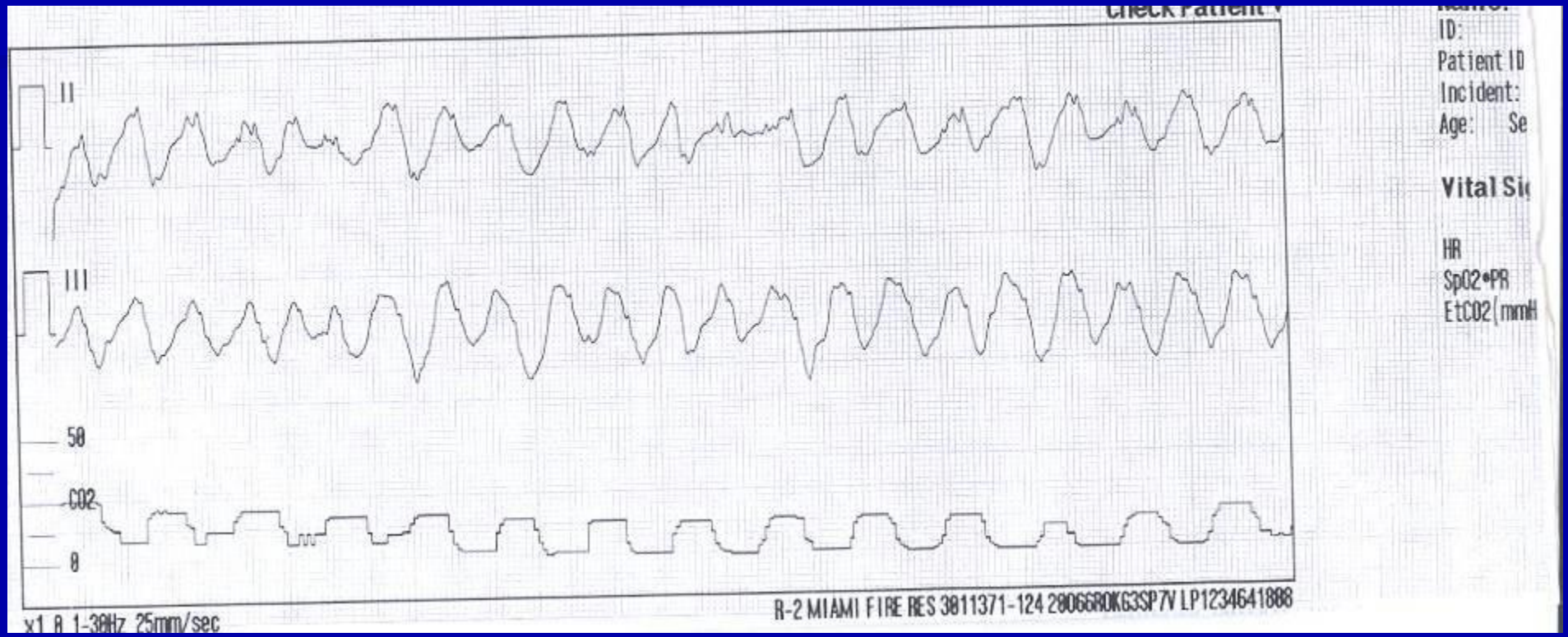
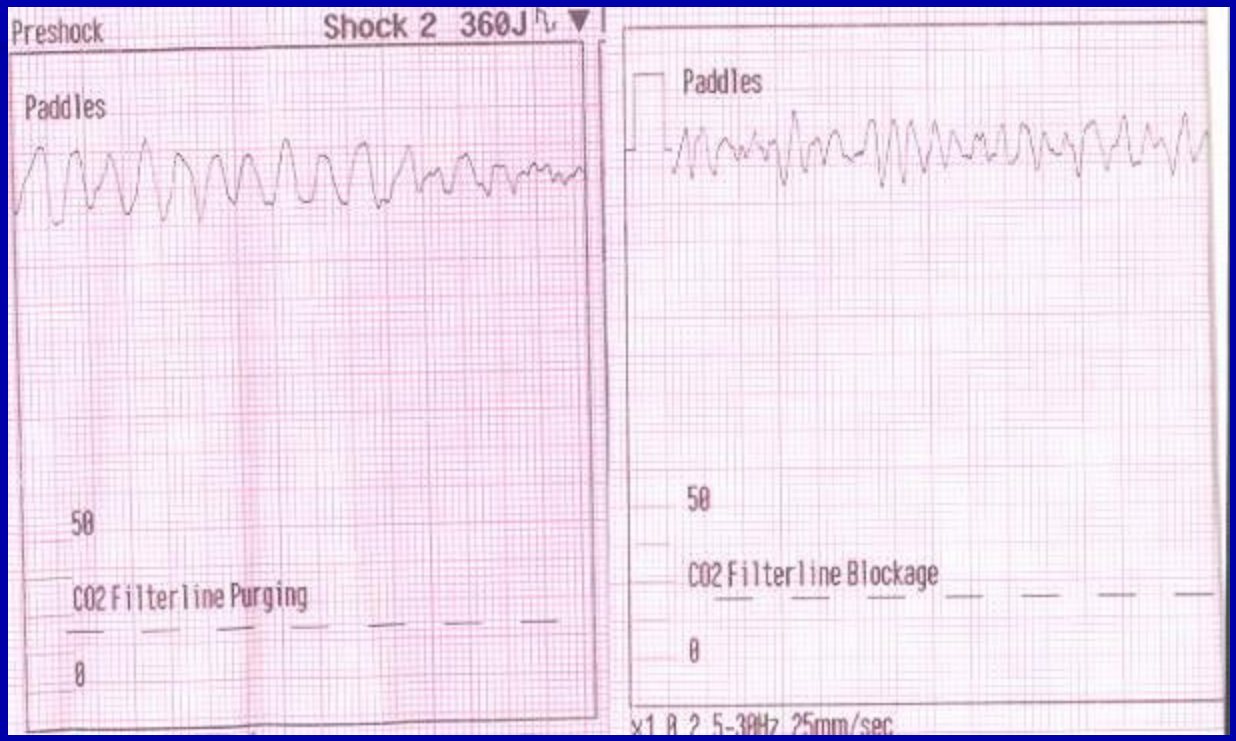

II
III
50
CO2
0
ID:
Patient ID
Incident:
Age:
Vital Si
HR
SpO2 PR
EtCO2 mmH
x1 B 1-30Hz 25mm/sec
R-2 MIAMI FIRE RES 3811371-124 2806GR0KG3SP7V LP1234641888

Sensor/Filter line blockage



Filter Line Blockage (LP 12)

'Purging…(30 seconds)…Filter Line Blocked'

- Will not re-start unless line disconnected 1st
- BVM: Tight seal on mask may kink line
- ETT:
  - Blood/fluids/vomitus = change filter line
  - Mechanical kink:
    - Re-straighten line, then disconnect and reconnect
    - If still bad, change to new filter line

$ETCO_2$ Resources

- www.capnography.com
- Emscapnography.blogspot.com
- Snohomishcountymedics.terapad.com
- www.biotel.ws/protocolsHTML/Protocols2004/capnographyinterpretation.asp
- www.physio-control.com/learning/clinical-topics/capnography.aspx

More trouble-shooting

- Pulse oximetry
- CO monitoring
- Pacer capture vs. electrical artifact
  - Dispersion from gel in defib/pacing pads
  - Must feel mechanical pulse to be sure, or
  - Artifact "QRS" will change amplitude with mAs, heart QRS will not
- 12 lead computer interpretations
- Automated BP readings

GENERAL PRINCIPLES #1

- Quick differential:
  - Problem with patient? machine? my brain?
- Treat the patient, NOT the machine
- Actions:
  - Recheck patient's ABCs (hands-on) and stabilize
  - Recheck machine
  - PUT THE WHOLE PICTURE TOGETHER!
- Psychology:
  - Doubt: Often hard to trust self over machine
  - Denial: Often hard to set one's ego aside and use machine info ("That tube is in, damn it")

GENERAL PRINCIPLES #2

- **Individual medic:**
  - Learn/practice/maintain your own EXCELLENT assessment skills
  - Use machine as assistant, NOT as a crutch
- **EMS System:**
  - Training and more training by skilled trainers
  - Med directors and lead paramedics MUST keep their hands on
  - Listen to your paramedics when they say there's a machine problem
  - Play with your machines to see what's not in the book
- **Companies: Listen to your customers, troubleshoot early, set up user groups or blogs for discussions**