After the Cardiac Arrest

March 2, 2018

Disclosures - Callaway

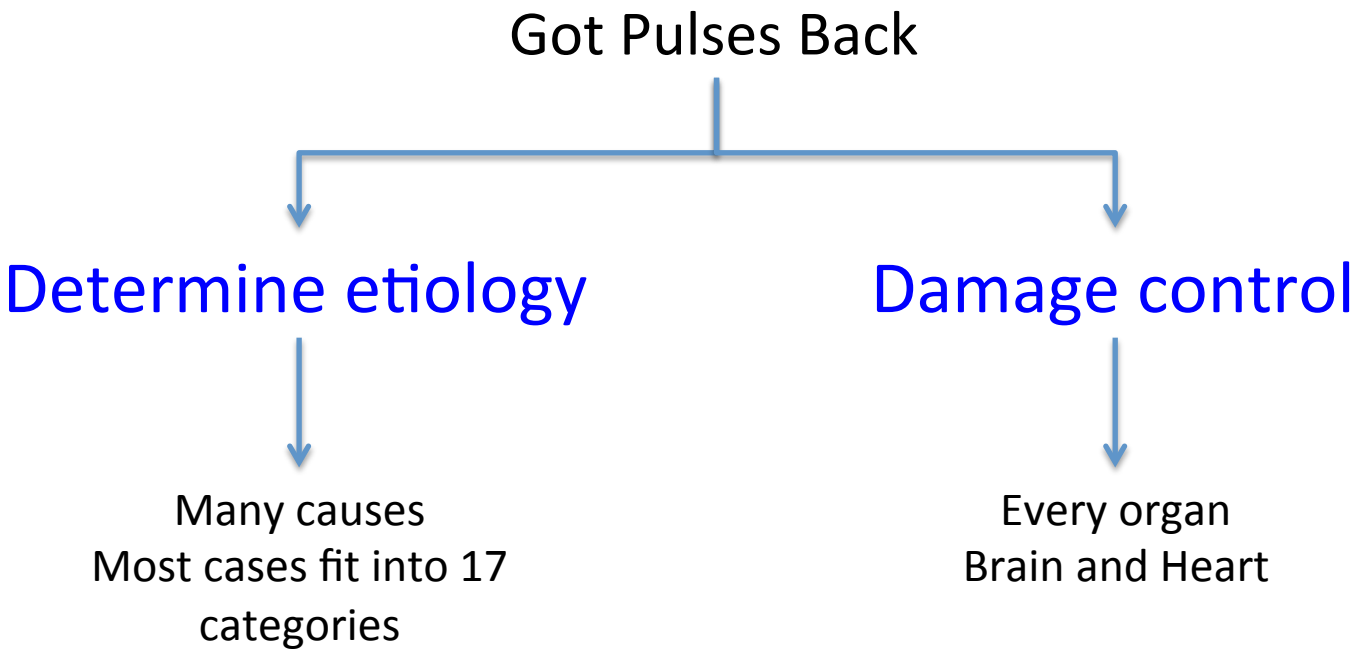
- Employer: University of Pittsburgh; UPMC Health Systems
- Grants: NHLBI (multicenter consortium to study cardiac and trauma resuscitation; institutional training grants); NINDS (NETT consortium to study neurological emergencies); NCATS (support for translational science research infrastructure)
- Patents: Use of ECG analysis to optimize timing of defibrillation; formerly licensed to Medtronic (terminated 2012).
- Research Support: Loan of cooling device from Medivance Inc, for laboratory studies of cooling

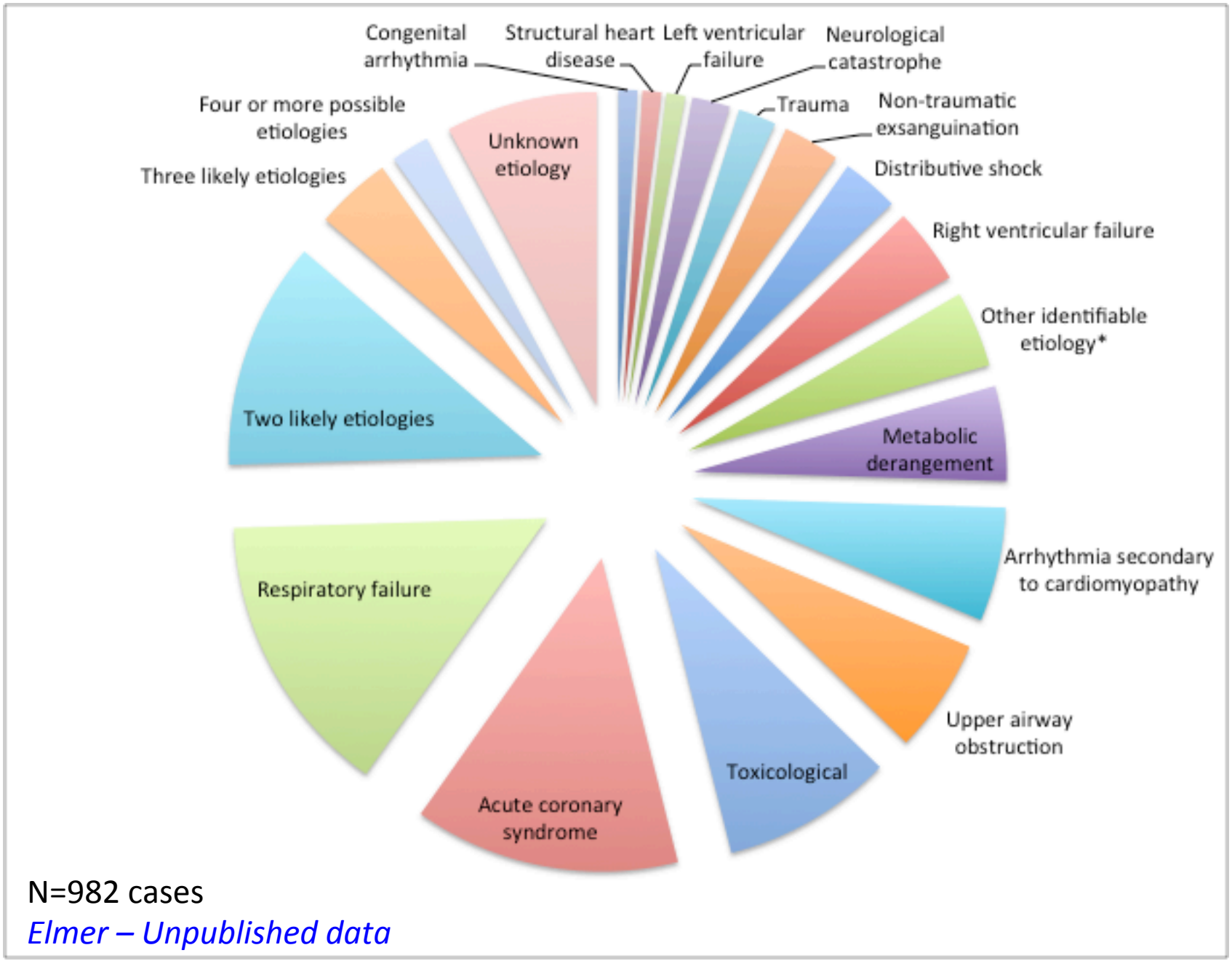
Room 1

Room 1 – 45 yo Female

- 45 yr old female collapsed at home while washing dishes. Her 18 yr old daughter and son-in-law do CPR for ~15 minutes awaiting EMS.
- Firefighter AED shocks x 2, EMS arrives to see asystole on monitor.
- Epinephrine, atropine and CPR restores pulses
- Amiodarone started by outside ED
- On arrival, patient has blood pressure of 150/70, on no pressors.
- ABG is pH 7.26 / 46 / 146 on FiO2 of 0.50; PEEP 5

Post-Cardiac Arrest Care





N=982 cases

Elmer – Unpublished data

17 Categories – Initial Eval

- Acute Coronary Syndrome (ACS)
- Primary Arrhythmia
- Congenital / Structural Heart Disease
- Secondary Arrhythmia (from cardiomyopathies)
- Cardiogenic Shock
- Pulmonary Hypertension / RV Failure

- Other Respiratory Failure (COPD, Asthma, etc.)
- Large Airway Obstruction

- Trauma (several specific entities)
- Non-Trauma Exsanguination (other acute anemia)

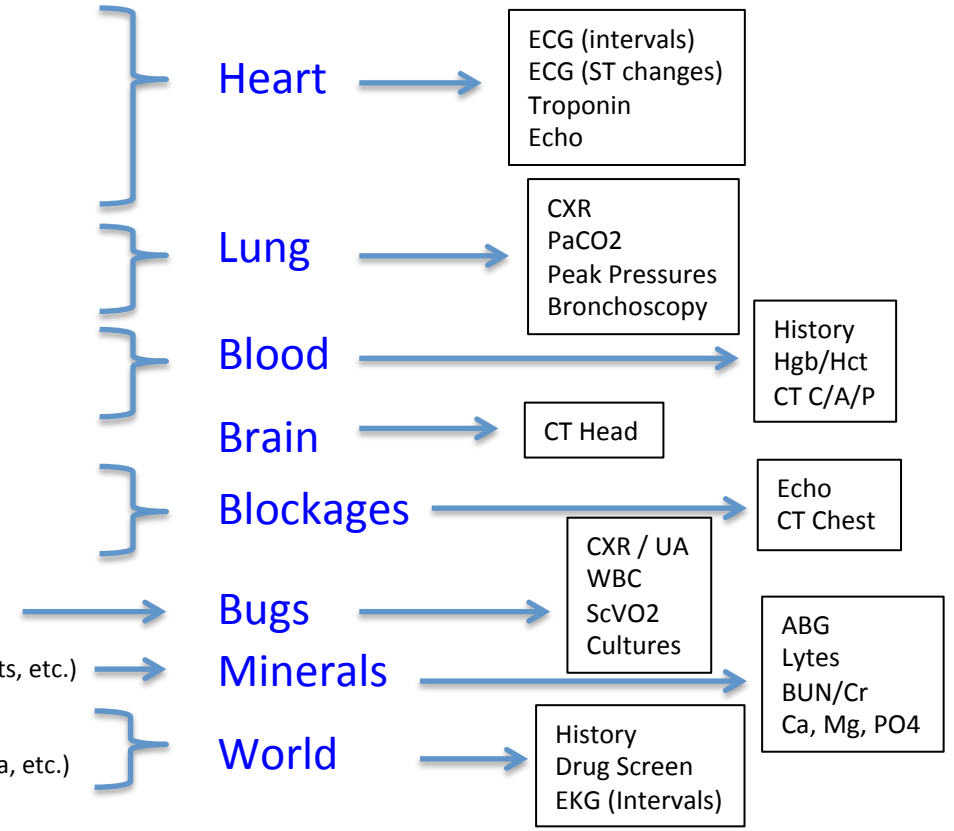
- Catastrophic CNS Event

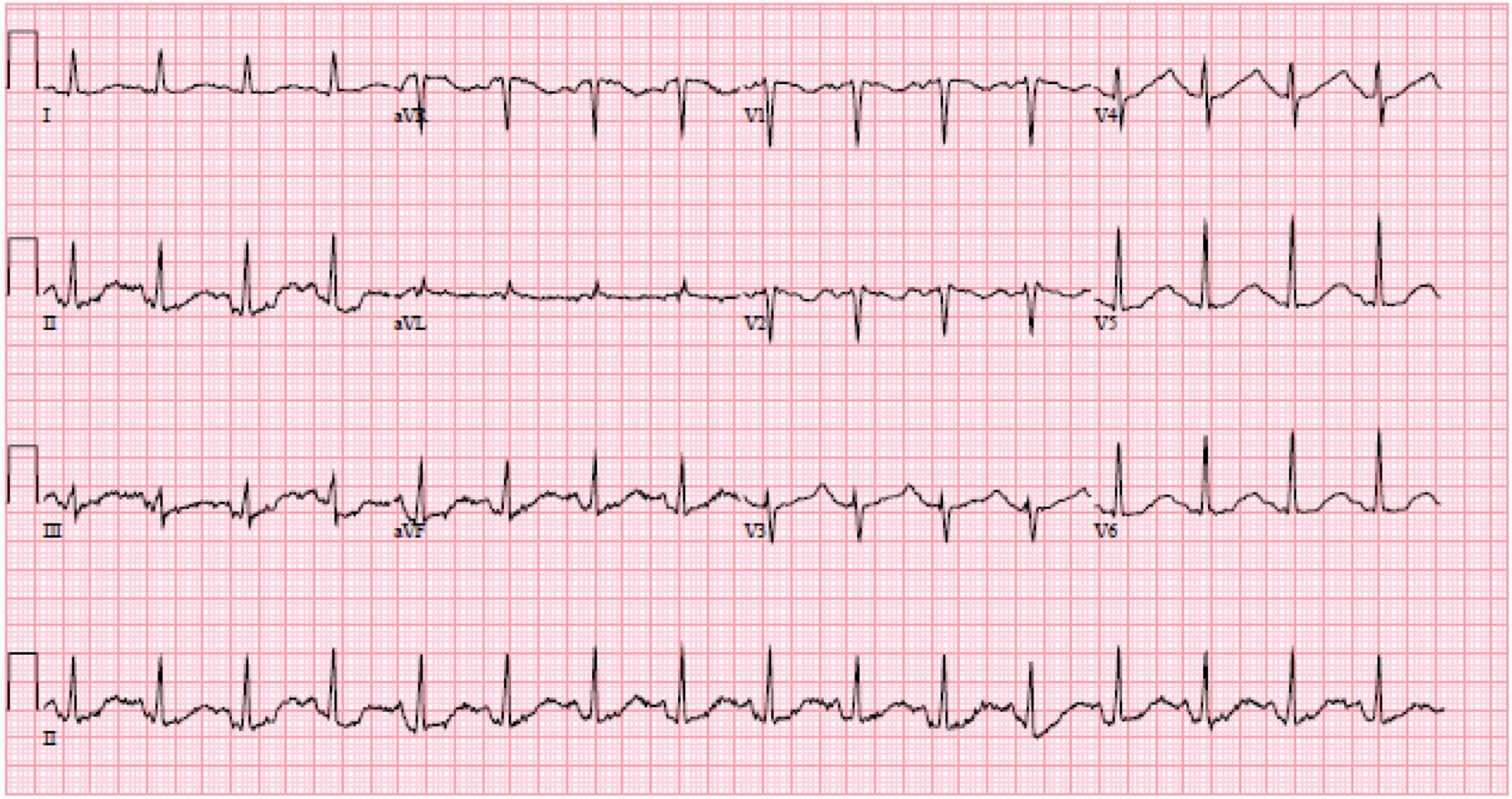
- Pulmonary Embolus
- Obstructive Shock

- Distributive Shock (sepsis)

- Metabolic Derangements (DKA, other electrolyte shifts, etc.)

- Toxicological
- Environmental Exposures (electrocution, hypothermia, etc.)





Troponin 8.2

Pearls

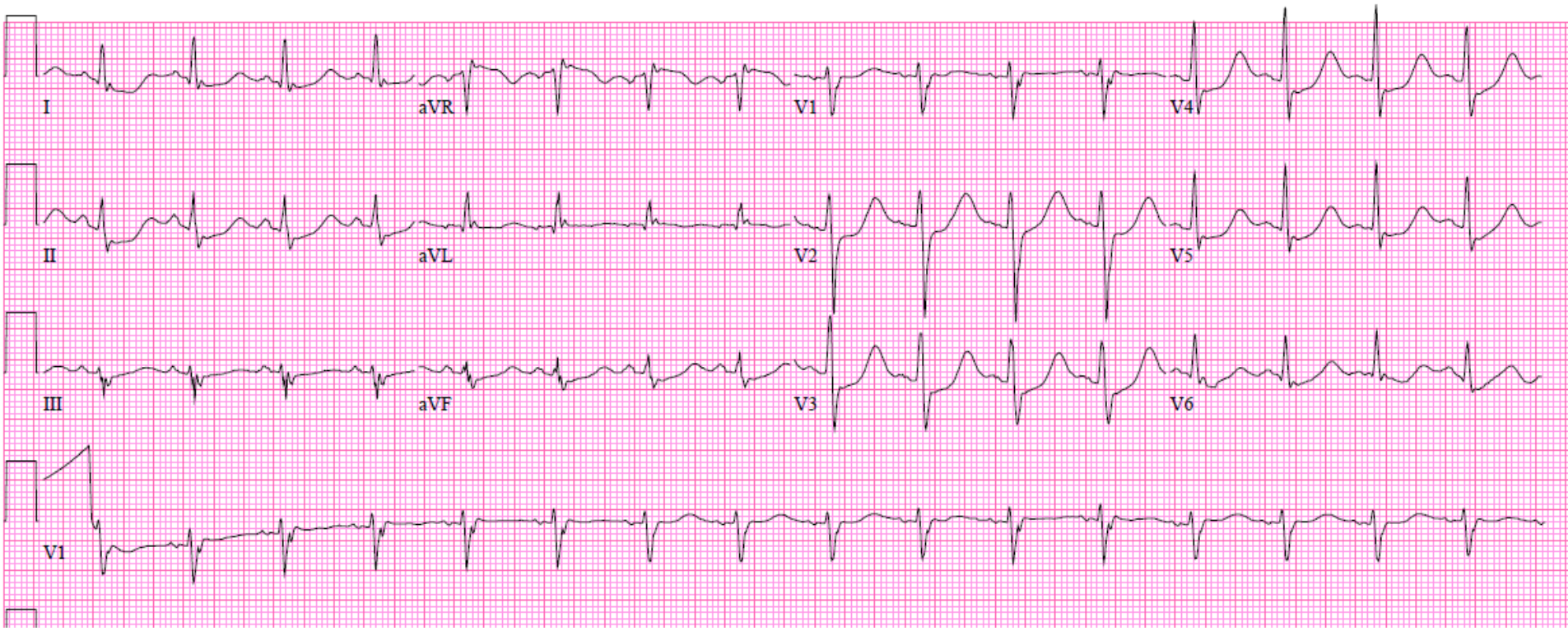
- Troponin rising = myocardial infarction
  - CPR and shocks do not cause significant rise in troponin by themselves
  - Troponin 0-2 is trivial leak / poor clearance
  - Troponin >5-7 is really an MI (but still could be supply-demand mismatch)
  - Troponin >10 is really and sincerely a blocked artery

Room 2

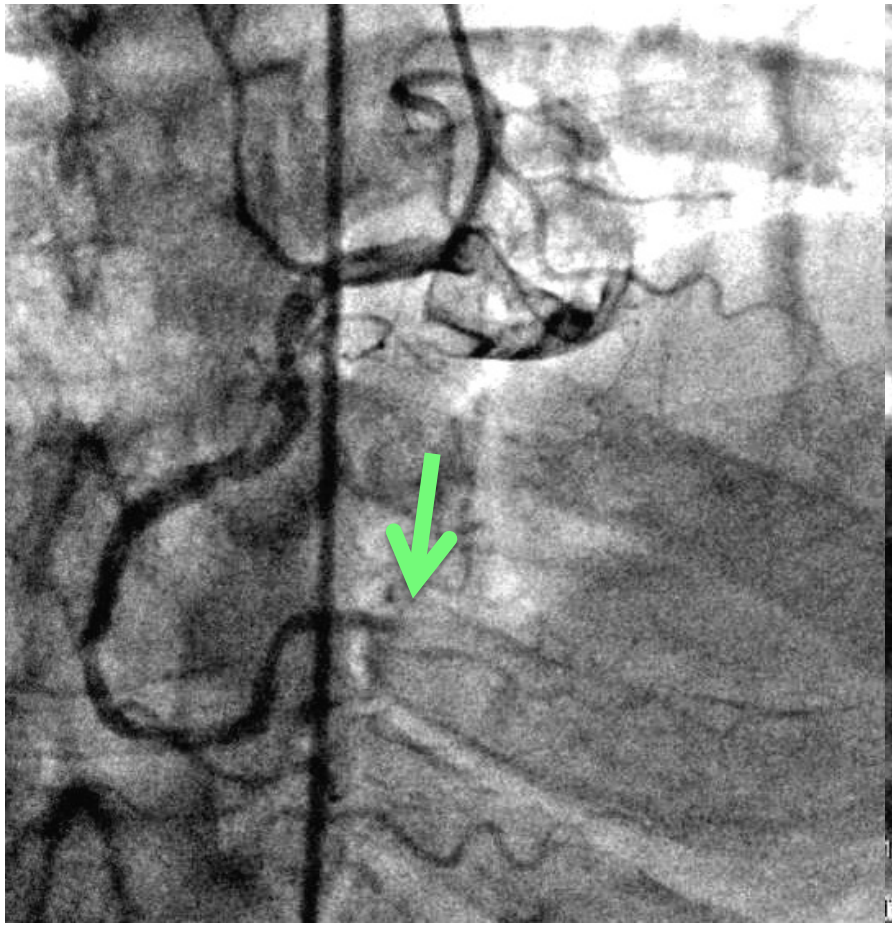
Room 2 – 30 yo male

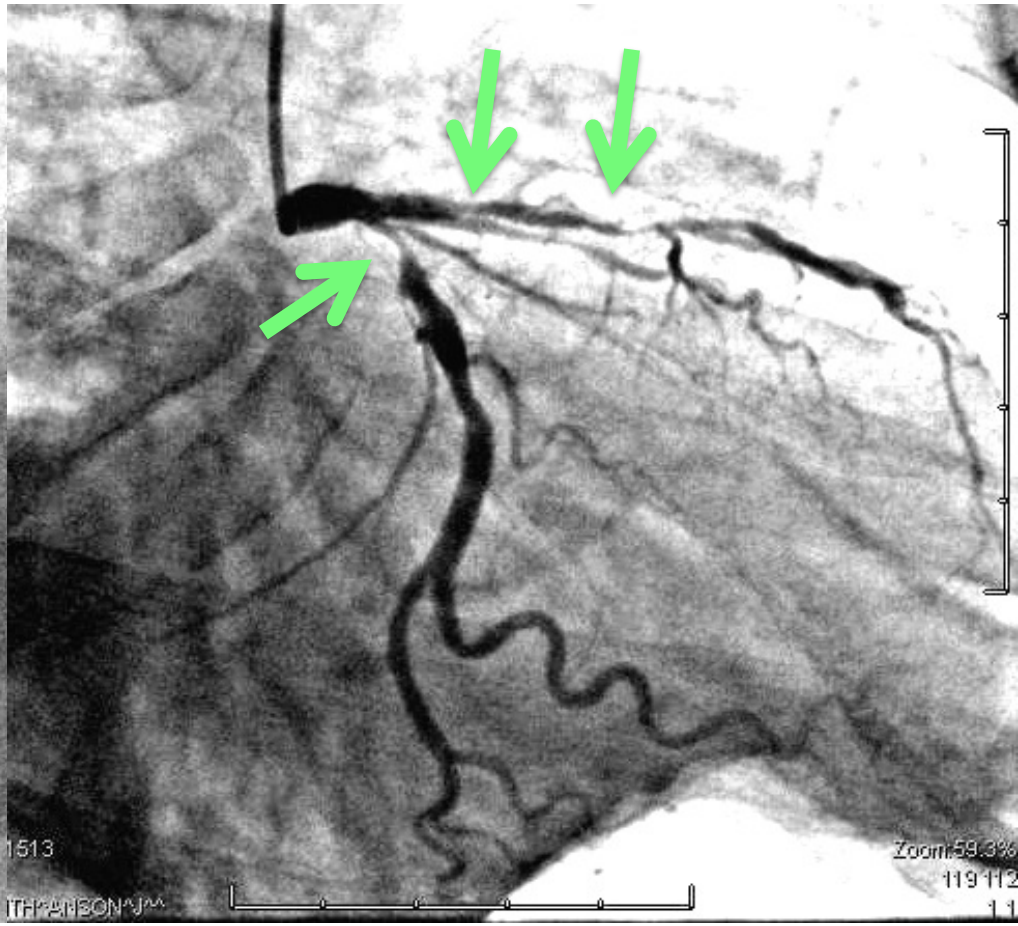
- 30 M took bottle of xanax at night. Partner finds him unresponsive at 5 am (gurgling). CPR x 60 min. Epi 11; atropine, HCO3.
- Arrives on 3 pressors. 94/60; HR 111; Temp 32.8.
- AST 680, ALT 104. Creat 2.1
- FiO2 1.0; 7.19/66/92; lactate 13
- Trop 27

- No pupils, corneals, gag, cough, breathing, oculocephalic or movement. Train of 4: 4/4

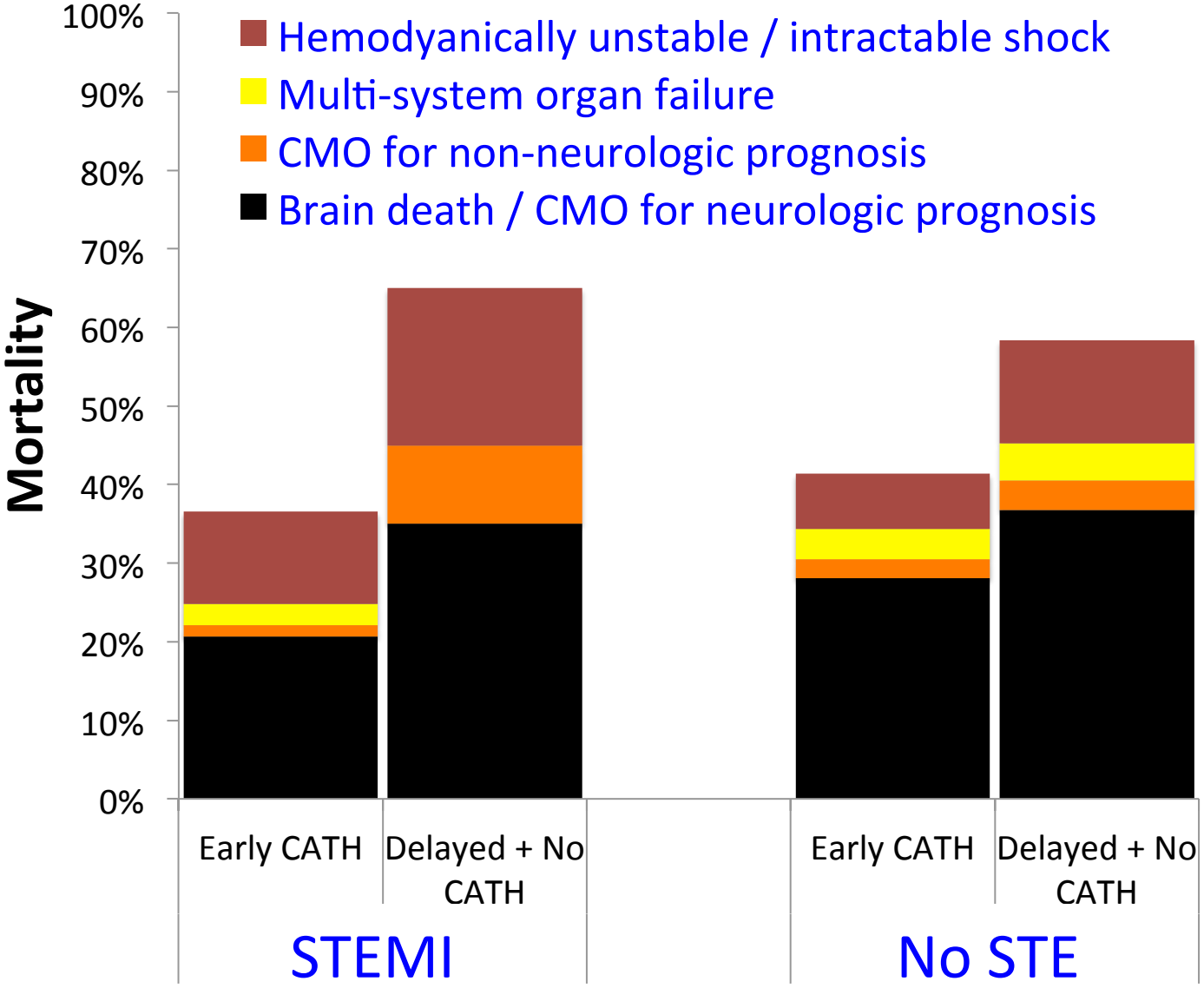

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

Cath





Reynolds, Resuscitation 2014



Reynolds 2013

Prognosis
for the Family and to Guide Therapy

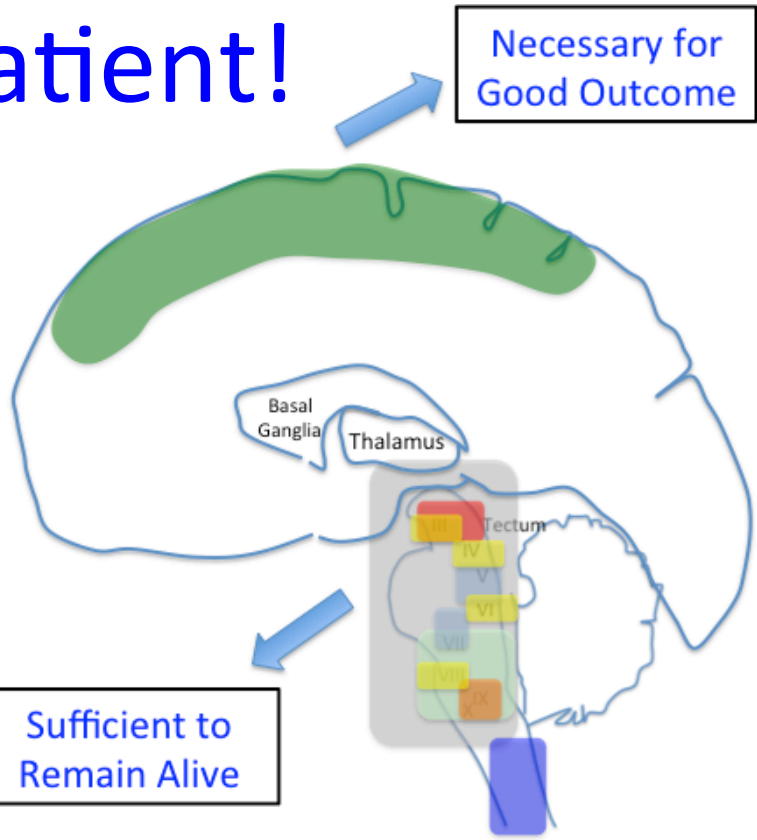
What are their chances of leaving hospital alive?

45%

Examine the Patient!

- Breathing
- **Pupils**
- **Corneals**
- Gag
- Cough
- Oculocephalic
- **Motor Response**
  - Nothing, Extension, Flexion, Withdrawal
  - Localize / Purposeful / Following commands

- Motor
  - Purposeful
  - Localize
  - Withdraw
  - Flexion
  - Extension
- Oculocephalic
- Pupils
- Corneals
- Gag
- Cough
- Breathing



Room 1 - 45 yo female)

- Initial neurological examination is
  - Pupils react (2 mm sluggish)
  - Corneal reflex present (blinks to rubbing eyelash)
  - Eyes deviated upward with no oculocephalic response
  - Triggers ventilator
  - Gag and cough present
  - Flexor posturing of extremities to pain

Room 2 – 30 yo male

- 30 M took bottle of xanax at night. Partner finds him unresponsive at 5 am (gurgling). CPR x 60 min. Epi 11; atropine, HCO3.
- Arrives on 3 pressors. 94/60; HR 111; Temp 32.8.
- FiO2 1.0; ABG 7.19/66/92; lactate 13
- AST 680, ALT 104. Creat 2.1
- Trop 27

- No pupils, corneals, gag, cough, breathing, oculocephalic or movement. Train of 4: 4/4

Post Cardiac Arrest Category

Examine coma and brainstem reflexes *(best motor response to voice or pain, pupil reaction to light, corneal response, gag, cough, spontaneous breathing)* ***and shock*** *(how much pressor is required to keep SBP>100 mmHg)* ***and pulmonary status*** *(can you oxygenate the patient)*

Category 1 Awake

Follows commands or makes purposeful movements (e.g. pulling at tubes and lines

Category 2 Coma without severe shock

Does not follow commands or make purposeful movement but brainstem reflexes are present. Modest pressor requirements (dopamine≤10 mcg/kg/min; norepinephrine ≤0.1 mcg/kg/min) and reasonable to oxygenate (e.g. SaO2 90-100% with standard pressure control ventilation)

Category 3 Coma with severe shock or pulmonary dysfunction

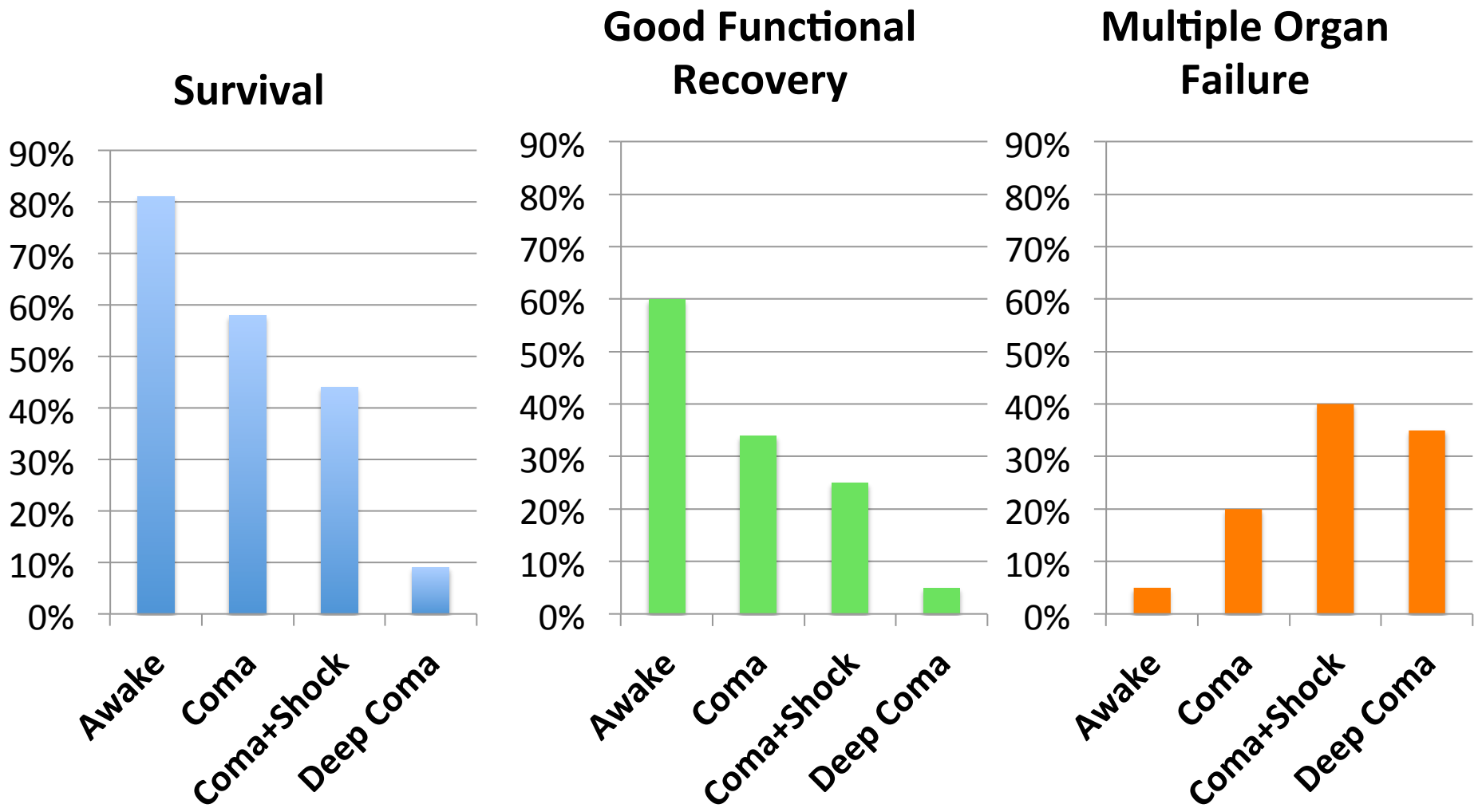
Does not follow commands or make purposeful movement but brainstem reflexes are present. High pressor requirements (e..g dopamine>10 mcg/kg/min; norepinephrine or epinephrine ≥0.1 mcg/kg/min) or very difficult to oxygenate (SaO2 <90% or requiring special ventilation modes)

Category 4 Coma with loss of brainstem reflexes

Does not follow commands or make purposeful movement and multiple brainstem reflexes are lost (e.g. no pupil response or gag or cough)..

Derivation: Rittenberger 2011; Resuscitation 82: 1399-1404
Validation: Coppler 2015; Resuscitation 89:86-92

Initial Illness Severity and Outcome

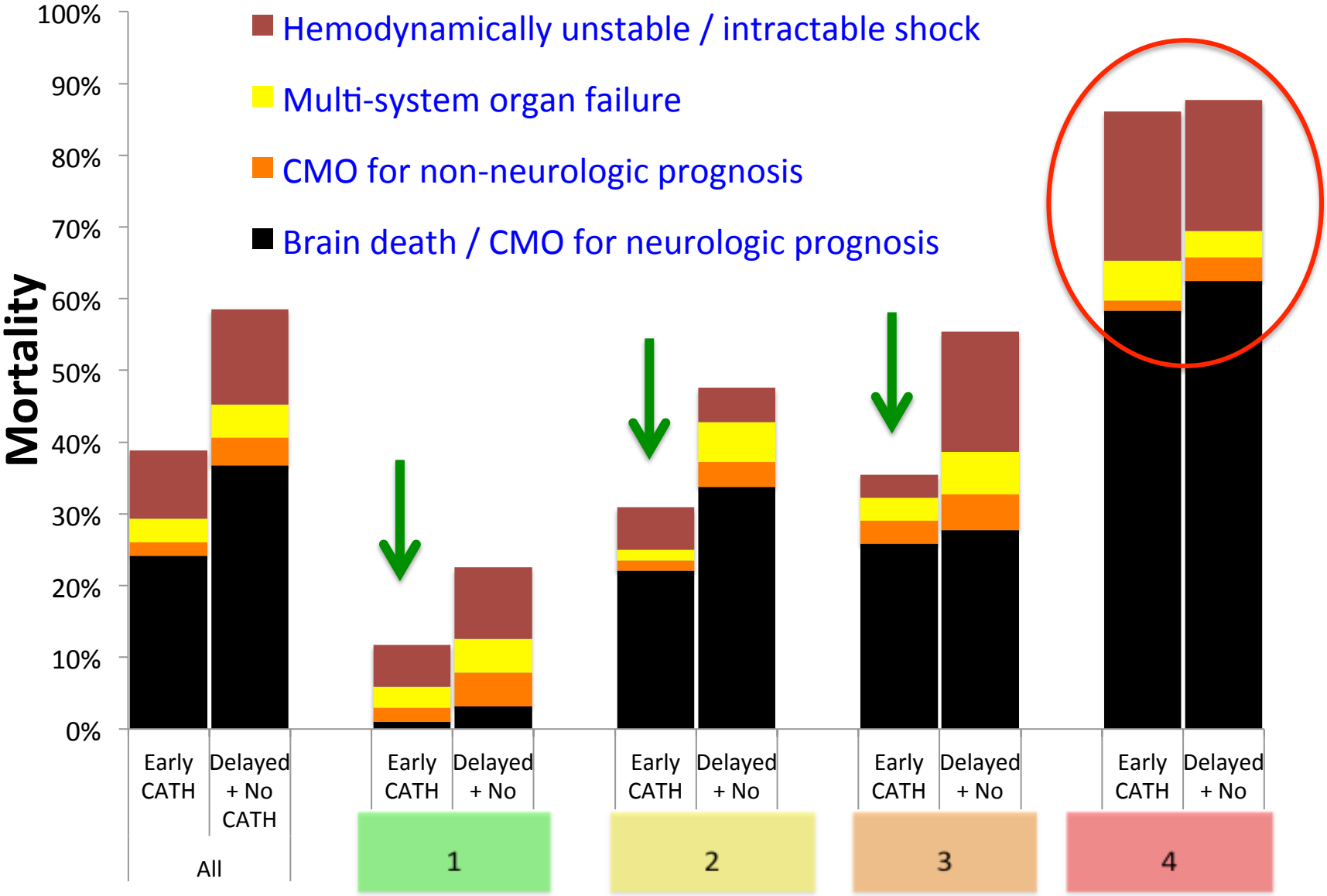


Derivation - Rittenberger 2011; Resuscitation 82: 1399-1404
Validation: Coppler 2015; Resuscitation 89:86-92

Expected Survival?

- Room 1 - 45 yr old female:
  - Triggers ventilator
  - Pupils react (2 mm sluggish)
  - Corneal reflex present
  - Eyes deviated upward with no oculocephalic response
  - Gag and cough
  - Flexor posturing of extremities to pain
  - Easy to ventilate, no pressors
- Room 2 – 30 yr old male
  - No Breathes over ventilator
  - No Pupils reaction
  - No Corneal reflex
  - No oculocephalic
  - No Gag, cough
  - No movement extremities

Reynolds, Resuscitation 2014



Survival: 1.92 (95%CI 1.20, 3.07; p=0.006)

Modified Rankin Scale: 1.95 (95%CI 1.12, 3.38; p=0.02)

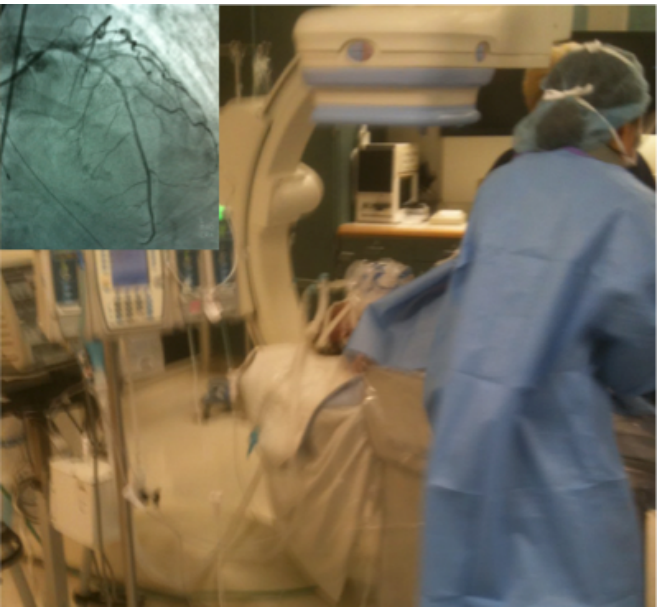
Customize care based on expectations

Post-Arrest STEMI

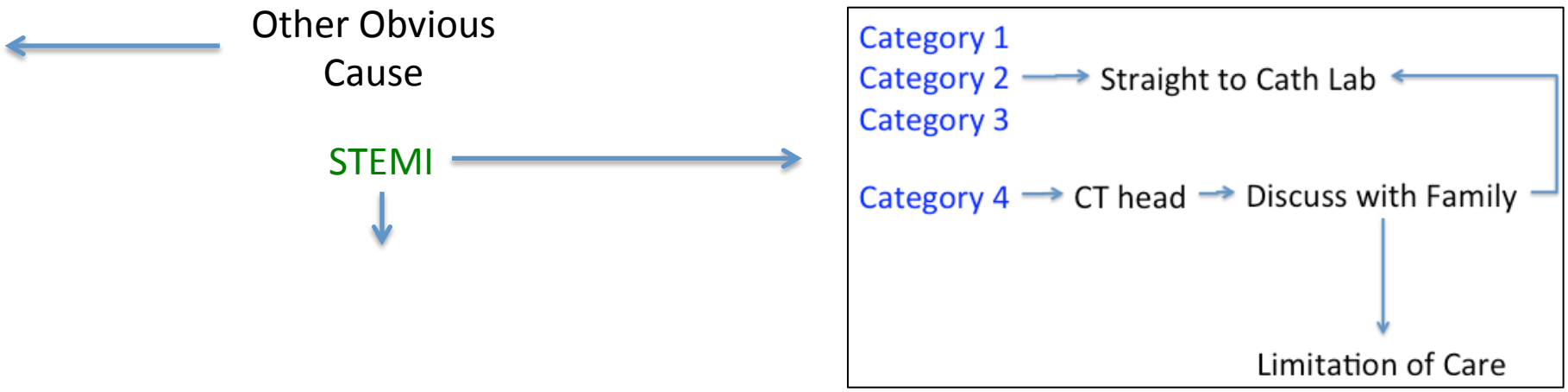
Category 1
Category 2 → Straight to Cath Lab
Category 3

Category 4 → CT head → Discuss with Family

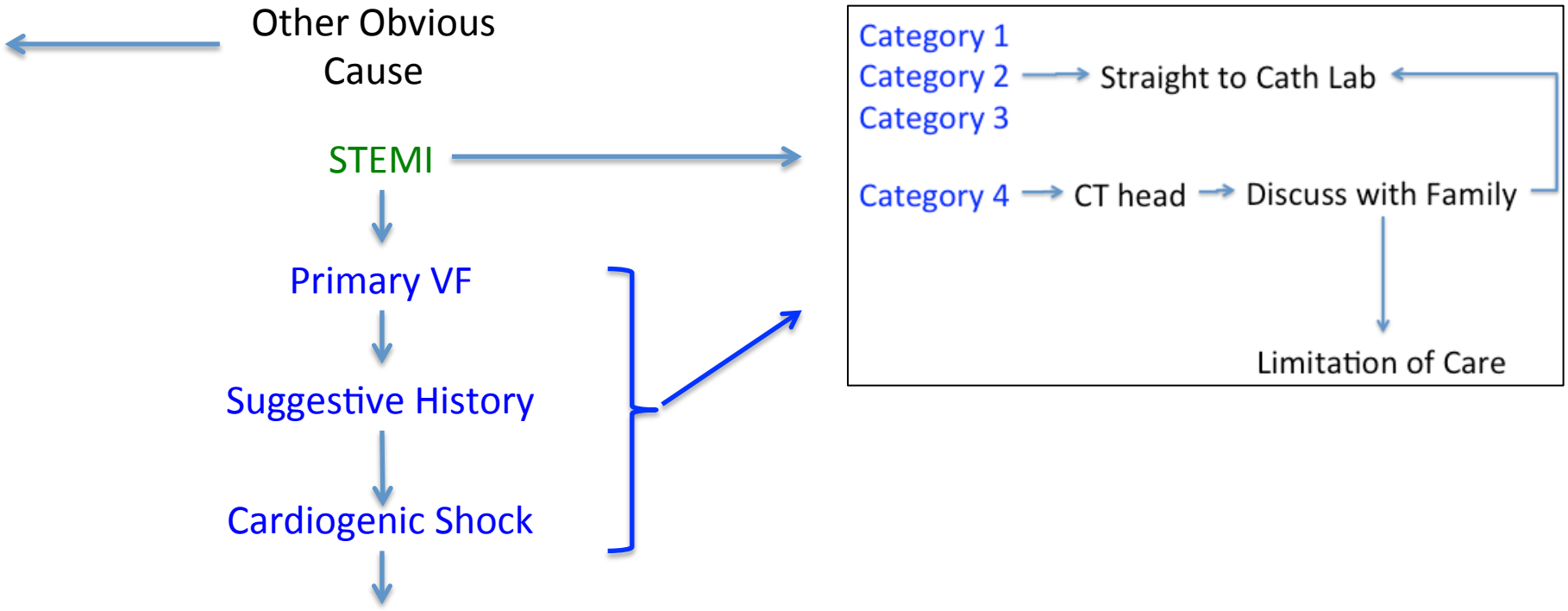
Limitation of Care



Who else goes to Cath?



Who else goes to Cath?



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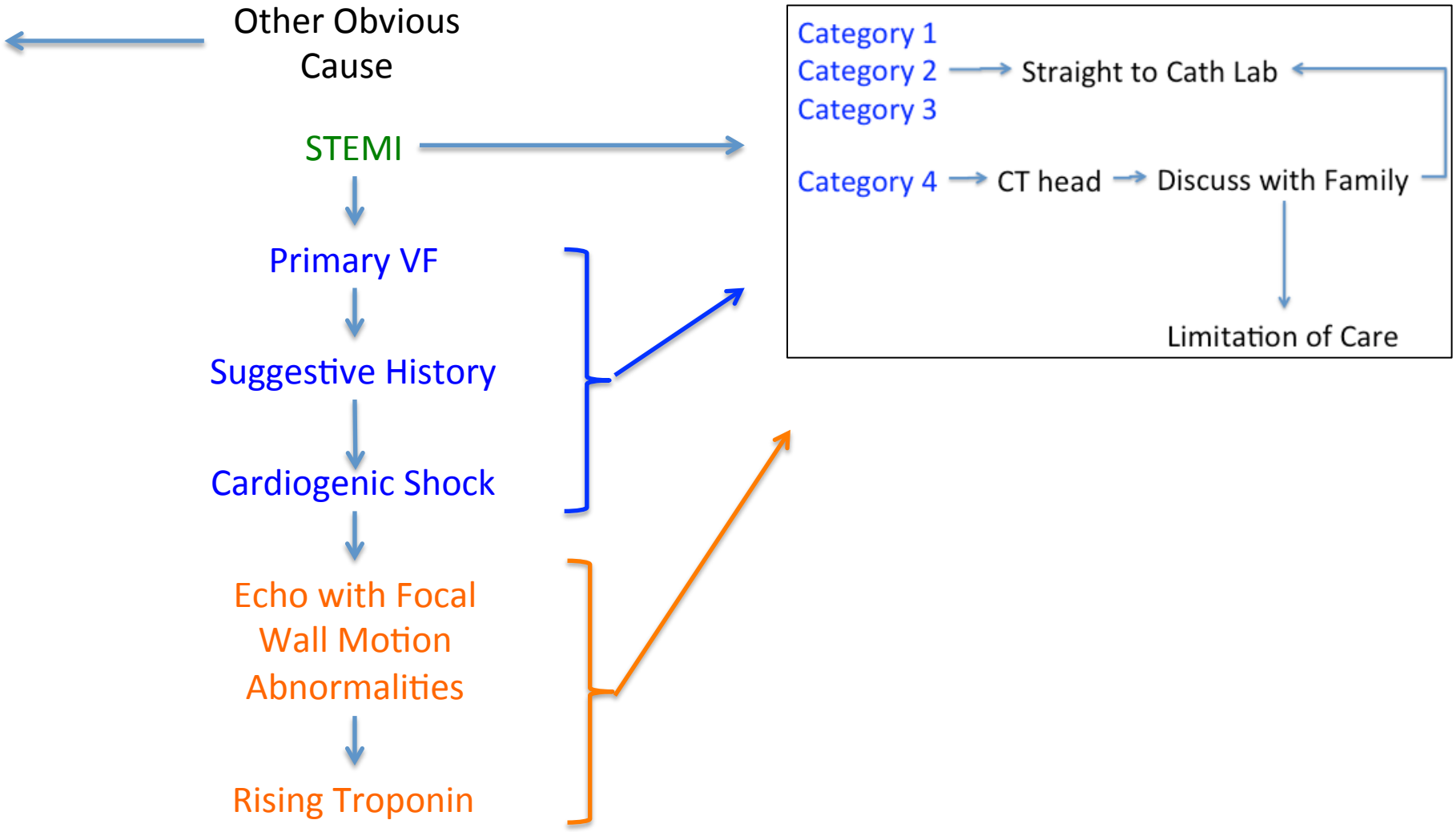

Room 2 – in ED

- 30 M took bottle of xanax at night. Partner finds him unresponsive at 5 am (gurgling). CPR x 60 min. Epi 11; atropine, HCO3.
- Arrives on 3 pressors. 94/60; HR 111; Temp 32.8.
- AST 680, ALT 104. Creat 2.1
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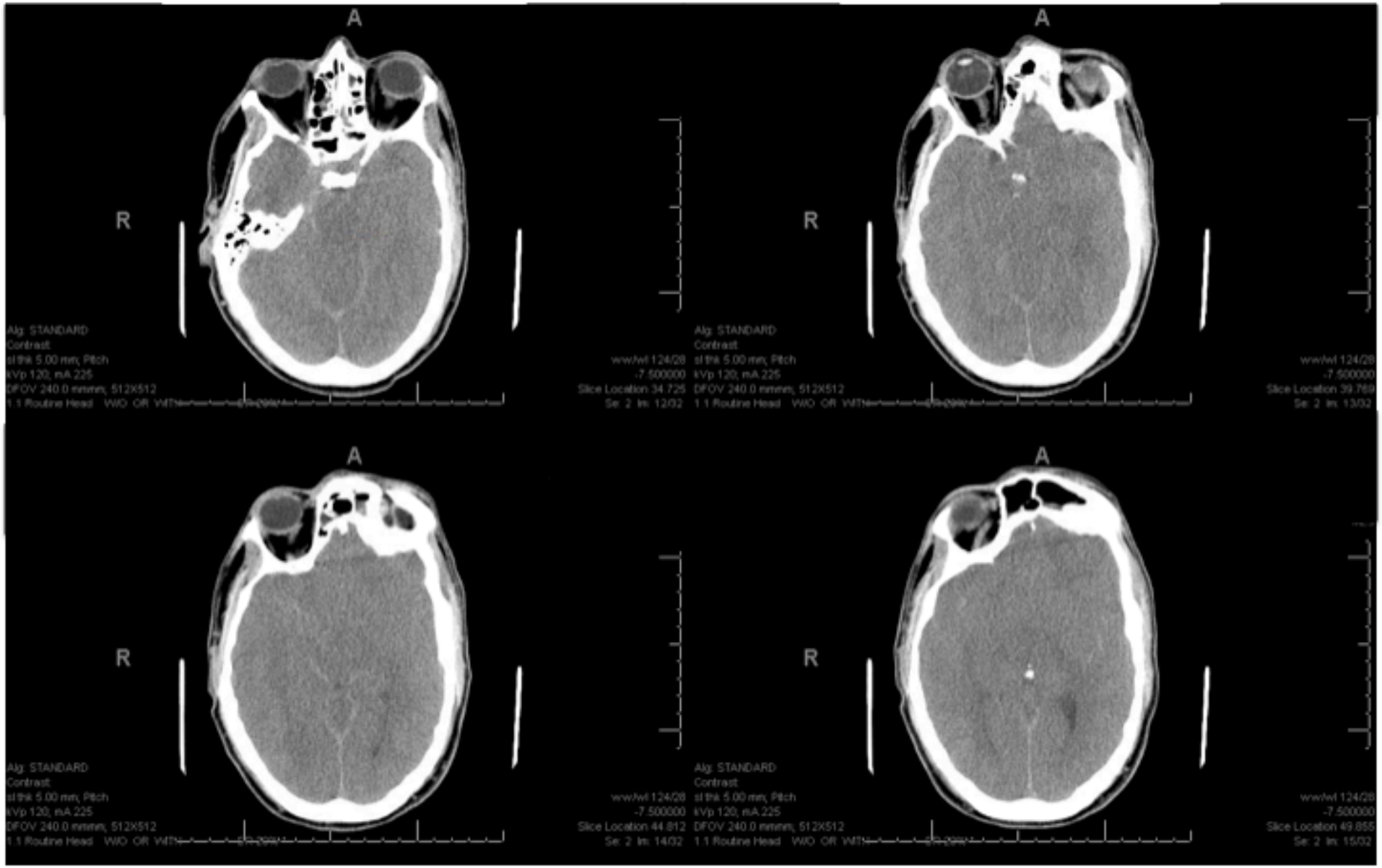
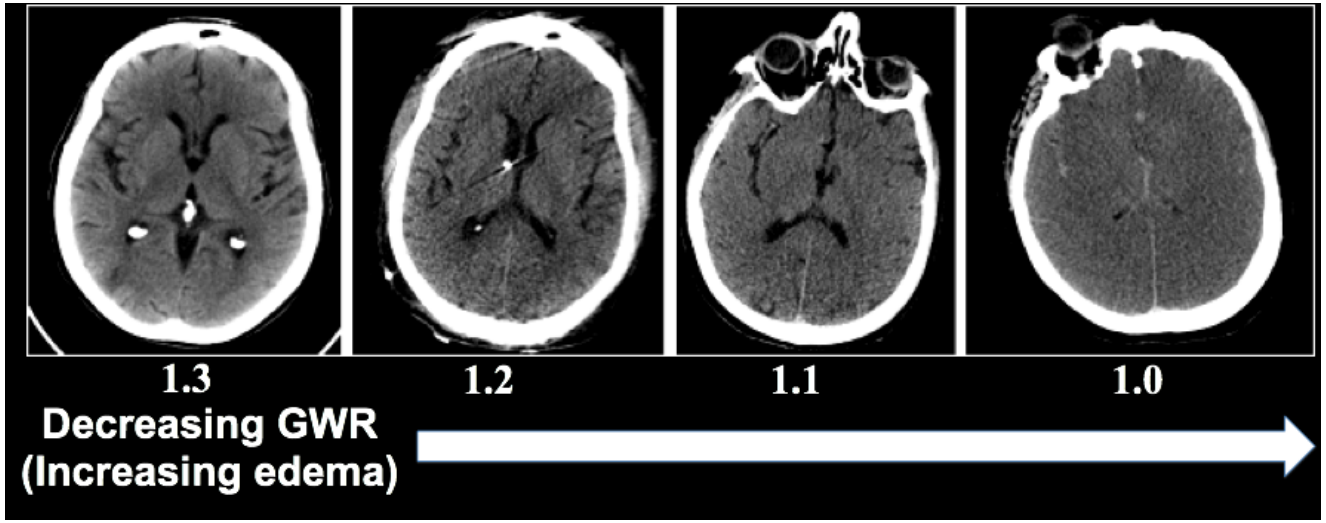
- More data?

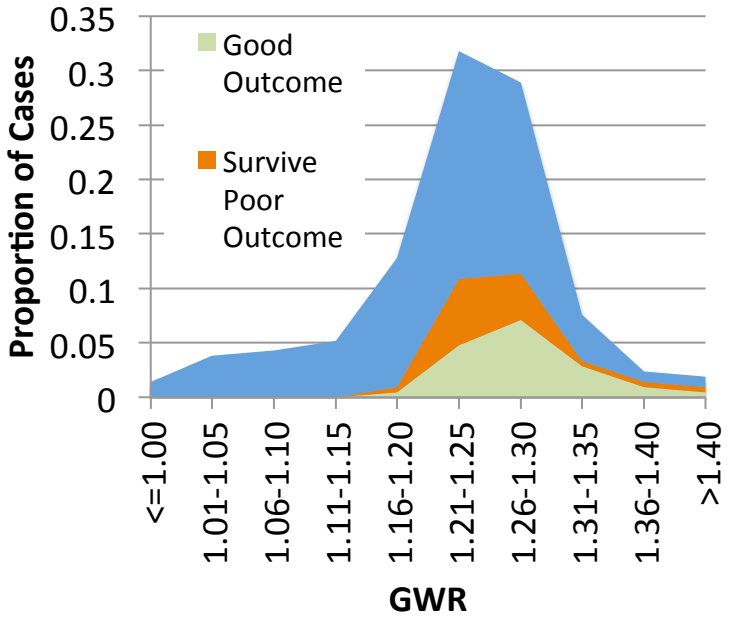

A
R
Alg: STANDARD
Contrast
sl thk 5.00 mm; Pitch
kVp 120; mA 225
DFOV 240.0 mmmm; 512X512
1.1 Routine Head W/O OR W/Th
ww/wl 124/28
-7.500000
Slice Location 34.725
Se: 2 Im: 12/32
A
R
Alg: STANDARD
Contrast
sl thk 5.00 mm; Pitch
kVp 120; mA 225
DFOV 240.0 mmmm; 512X512
1.1 Routine Head W/O OR W/Th
ww/wl 124/28
-7.500000
Slice Location 39.769
Se: 2 Im: 13/32
A
R
Alg: STANDARD
Contrast
sl thk 5.00 mm; Pitch
kVp 120; mA 225
DFOV 240.0 mmmm; 512X512
1.1 Routine Head W/O OR W/Th
ww/wl 124/28
-7.500000
Slice Location 44.812
Se: 2 Im: 14/32
A
R
Alg: STANDARD
Contrast
sl thk 5.00 mm; Pitch
kVp 120; mA 225
DFOV 240.0 mmmm; 512X512
1.1 Routine Head W/O OR W/Th
ww/wl 124/28
-7.500000
Slice Location 49.855
Se: 2 Im: 15/32

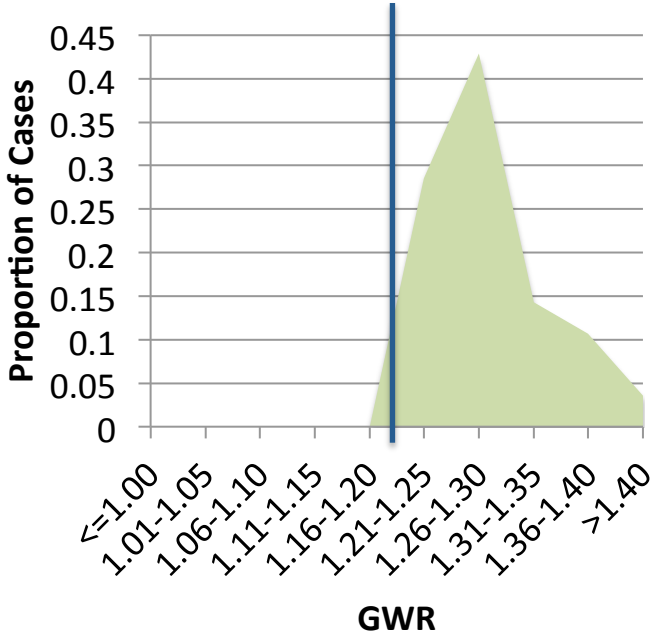
Cerebral Edema



GWR: Ratio of Hounsfeld Units in Gray Matter to White Matter

Decreasing GWR represents increasing cerebral edema. Normal brain GWR is near 1.3. Sulcal effacement is evident in GWR 1.1. Ventricular collapse, loss of cisterns, pseudosubarachnoid hemorrhage or even herniation is evident in GWR 1.0

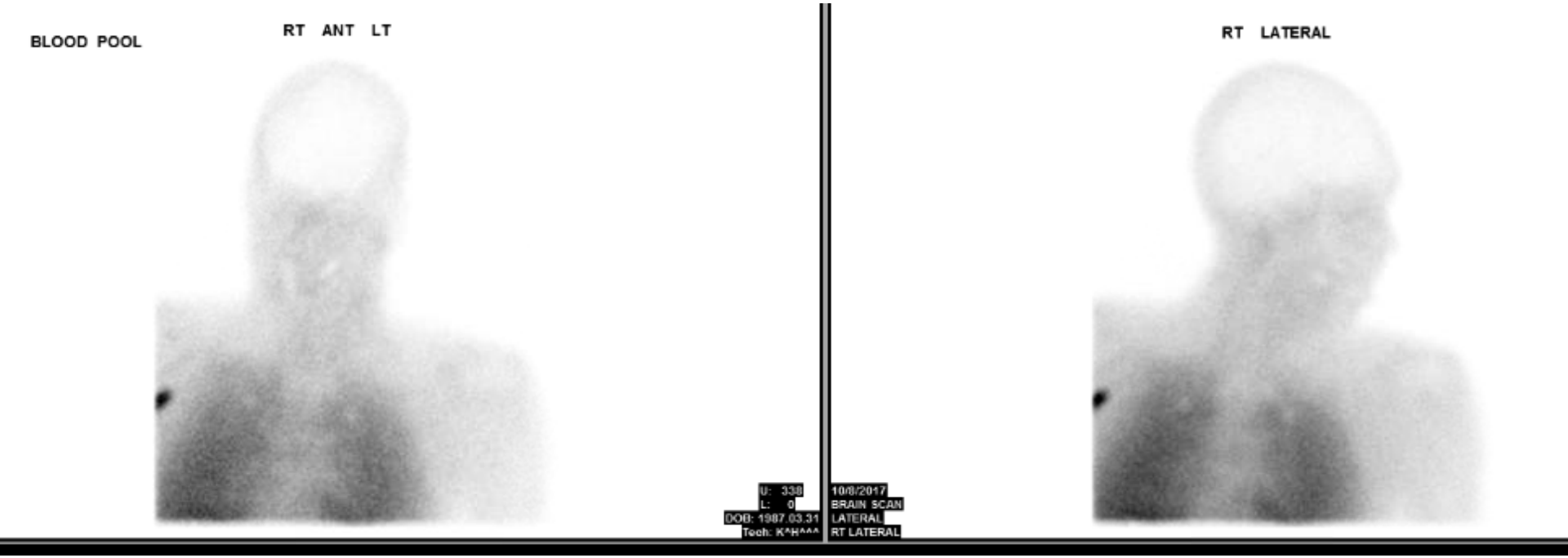




Metter 2011; Resuscitation 82: 1180-5

Room 2 – Hospital Course

- Warm to brain death exam
  - Timing? Drug levels? Other studies?



Pearls

- During cardiac arrest, lactate rises to 15-17 then plateaus
  - Lactate 5-10, high probability of survival
  - Lactate >15 – probably has some ischemic tissue (too high to attribute to cardiac arrest)

Room 3

Room 3 – 66 yo Male

- 66 yr old male, riding in car to go to park where he and his wife walk. Wife notices he is not responding to her conversation. Thought he was sleeping. Then she realizes he is really not right.
- Stops car, calls 911. Five minutes later EMS arrives. VF.
- Shock x 3. Epinephrine Lidocaine. Pulses within 10 min. To local ED.
- Easy to ventilate
- EKG with STE
- PCAC 2; CT head OK
- ED -> cath lab -> PCI of LAD

Who is better?

- Room 1 - 45 yr old female:
  - Triggers ventilator
  - Pupils react (2 mm sluggish)
  - Corneal reflex present
  - Eyes deviated upward with no oculocephalic response
  - Gag and cough
  - Flexor posturing of extremities to pain
- Room 3 - 66 yr old male
  - Breathes over ventilator
  - Pupils react
  - Corneal reflex present
  - No oculocephalic
  - Gag, cough
  - Flexion UE and LE

Who is better?

- Room 1 - 45 yr old female:
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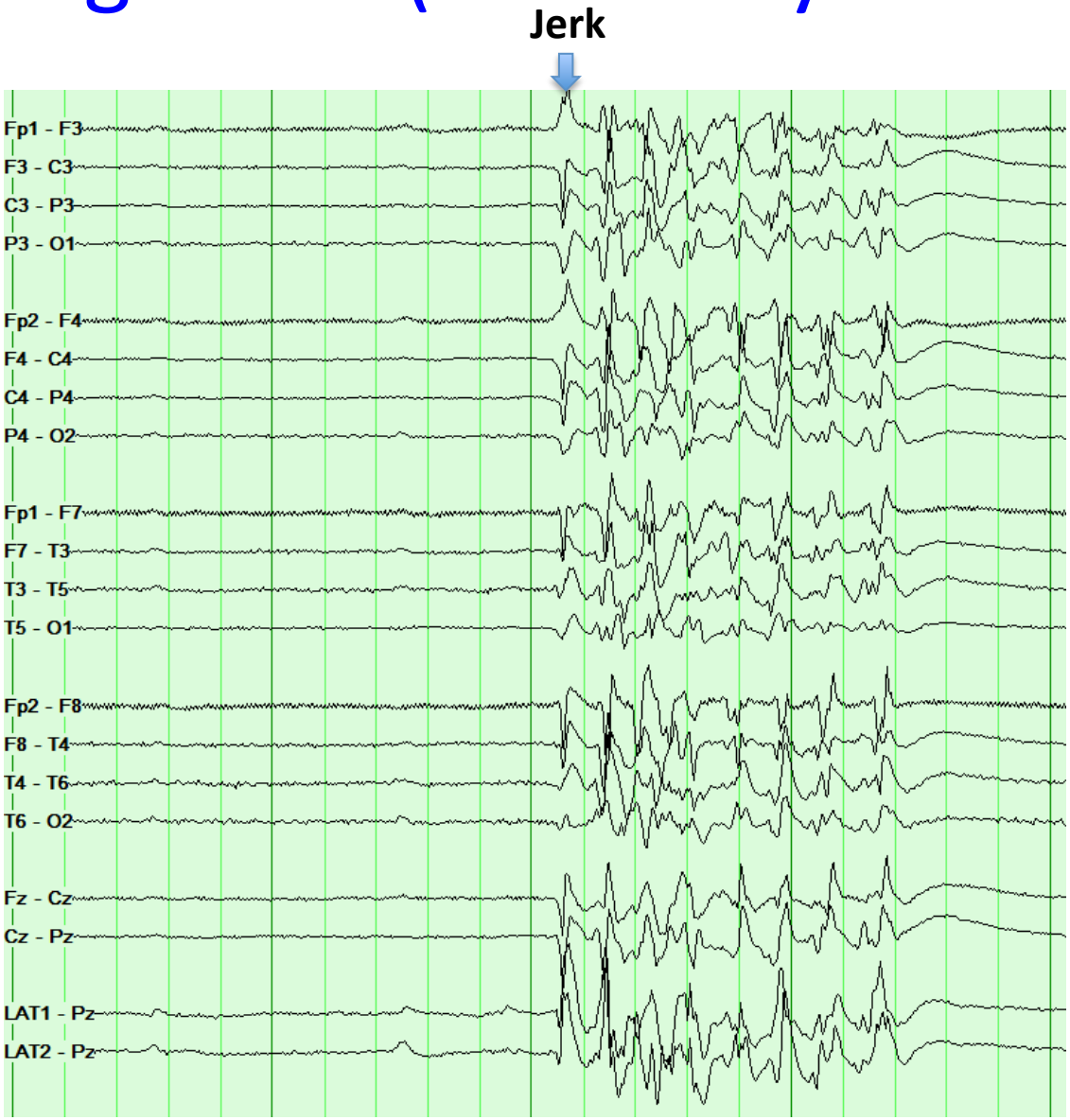
  - Pupils react (2 mm sluggish)
  - Corneal reflex present
  - Eyes deviated upward with no oculocephalic response
  - Gag and cough
  - Flexor posturing of extremities to pain

- Room 3 - 66 yr old male
  - Breathes over ventilator
  - Pupils react
  - Corneal reflex present
  - No oculocephalic
  - Gag, cough
  - Flexion UE and LE
  - Starts to have whole body jerks, eyes pop open and deviate up

Room 3 – Polyspike Bursts-Suppressed Background (status myoclonus)



Room 1

Room 1 – Continuous with attenuation

Exams at Day 3

- 45 yo female, day 3
  - Pupils react (4 mm)
  - Corneal reflex present
  - Oculocephalic reflex present
  - Gag and cough present
  - Triggers ventilator
  - Withdraws extremities to pain
- 66 yo male, day 3
  - Pupils react
  - Corneal Reflex: No.
  - Oculocephalic: No.
  - Gag Reflex: No.
  - Cough: No.
  - Spontaneous Breath: Yes.
  - Motor Exam: Nothing to pain.

Minimal Pressors, Easy to Oxygenate

Room 3 - 66 yo male

- Clinical exam worsened to bad
  - Combined with Status Myoclonus (of the malignant variety), no real expectation of good recovery
  - In similar patients, SSEP has absent N20
- Wife opts for withdrawal of life-sustaining therapies
  - Dies in next few hours (Day 4 after cardiac arrest)

45 yo female

- On day 4, check MRI
  - Reading is “Early ischemic changes in medial occipital lobes bilaterally.“

45 yo female

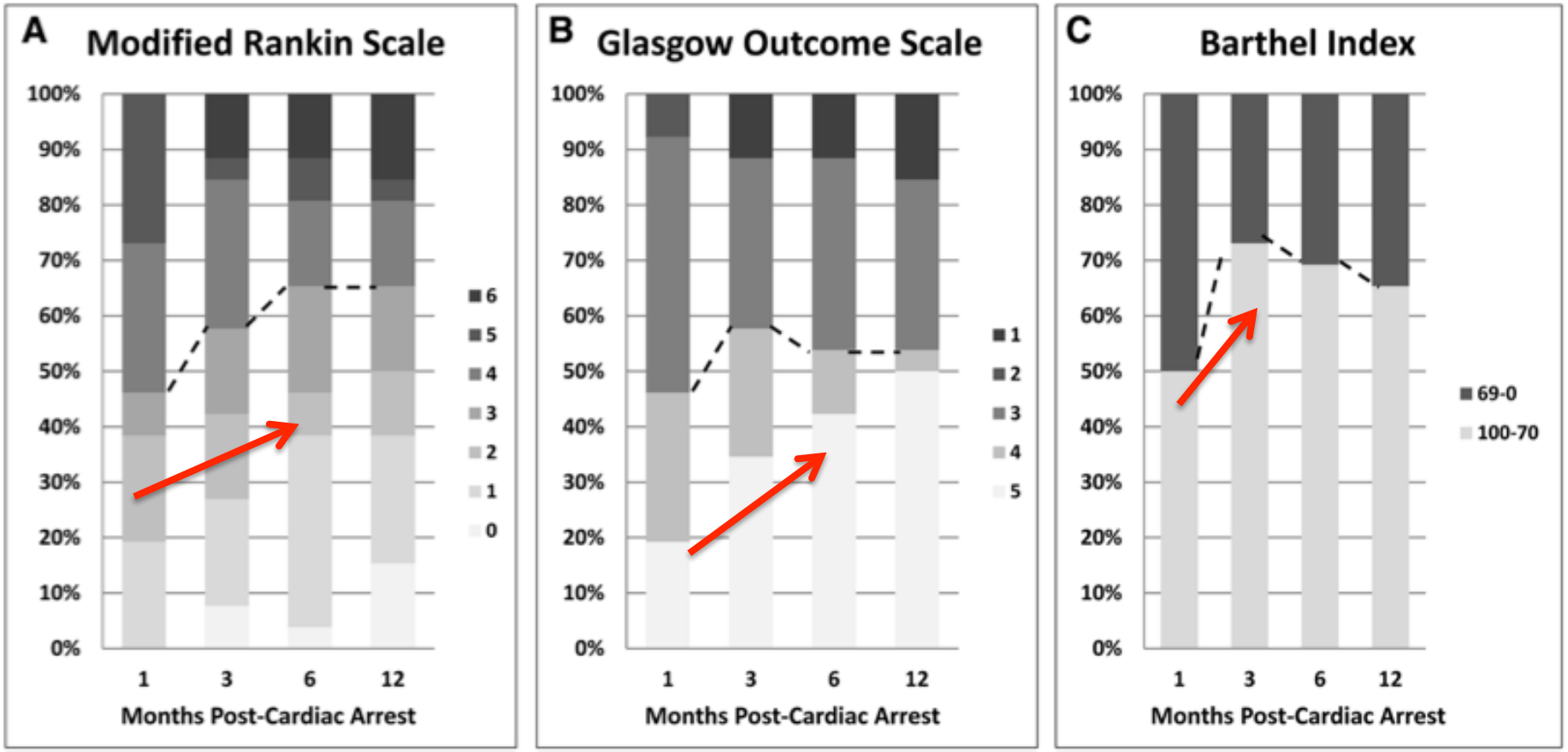
- Clinical Exam is unchanged for a week
  - Primary team, neurology and we advise that recovery is unlikely
  - Daughter states "This is my mom. I just can't handle pulling the plug."
  - Palliative care meets with family, but goals remain the same
- PEG and Trach on Day 14

45 yo female

- After 29 days, patient awakens!
  - Recalls going into kitchen to wash dishes, then nothing for 1 month
- Weak and drowsy, but improves daily
  - Reverses DNR status
  - Consents for implantable defibrillator (ICD)
- PM&R takes to inpatient TBI Rehab –
  - Starts on day 42 (after ICD)
  - "Alert, oriented to person, place, year but not exact date…weak voice…recalls 3/3 items at 1 minute; 1/3 at 5 minutes…"

Functional Neurologic Outcomes Change Over the First 6 Months After Cardiac Arrest

Julia T. Tong, BA[1]; Irina Eyngorn, MD[1]; Michael Mlynash, MD[1]; Gregory W. Albers, MD[2]; Karen G. Hirsch, MD[2]



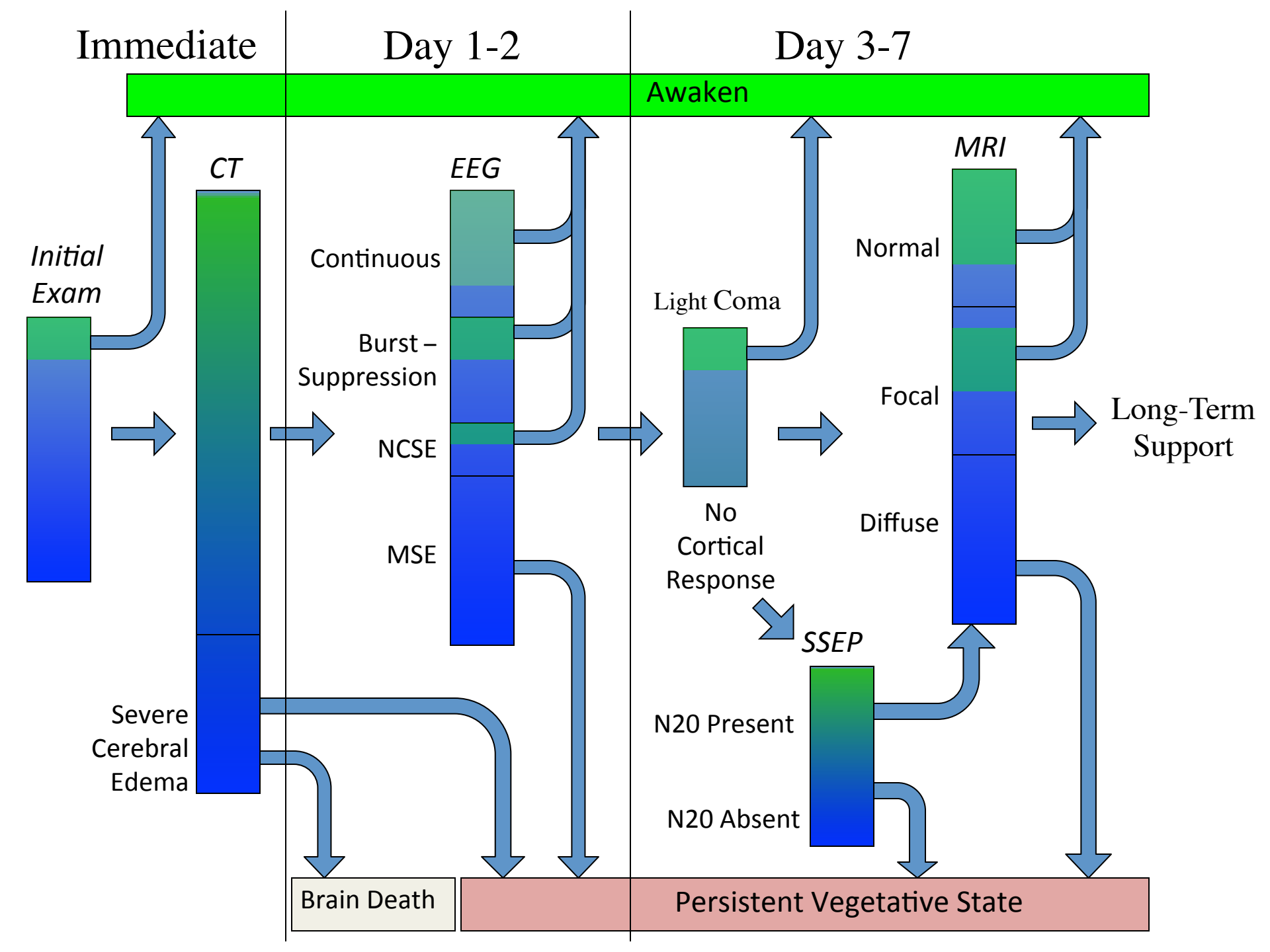
Crit Care Med 2016; 44:e1202–e1207

45 yo female

- Anticonvulsants tapered off during rehab

- PM&R discharge on day 47
  - Assist for transfers.
  - Ambulates 300 feet with wheeled walker
  - Supervision for stair climbing of 12 stairs
  - Independent grooming
  - Assistance for other ADLs

  - Some visual limitations (occipital ischemia on DWI!)


Immediate
Day 1-2
Day 3-7
Awaken
Initial Exam
CT
EEG
MRI
Continuous
Burst – Suppression
NCSE
MSE
Light Coma
No Cortical Response
SSEP
N20 Present
N20 Absent
Normal
Focal
Diffuse
Long-Term Support
Severe Cerebral Edema
Brain Death
Persistent Vegetative State

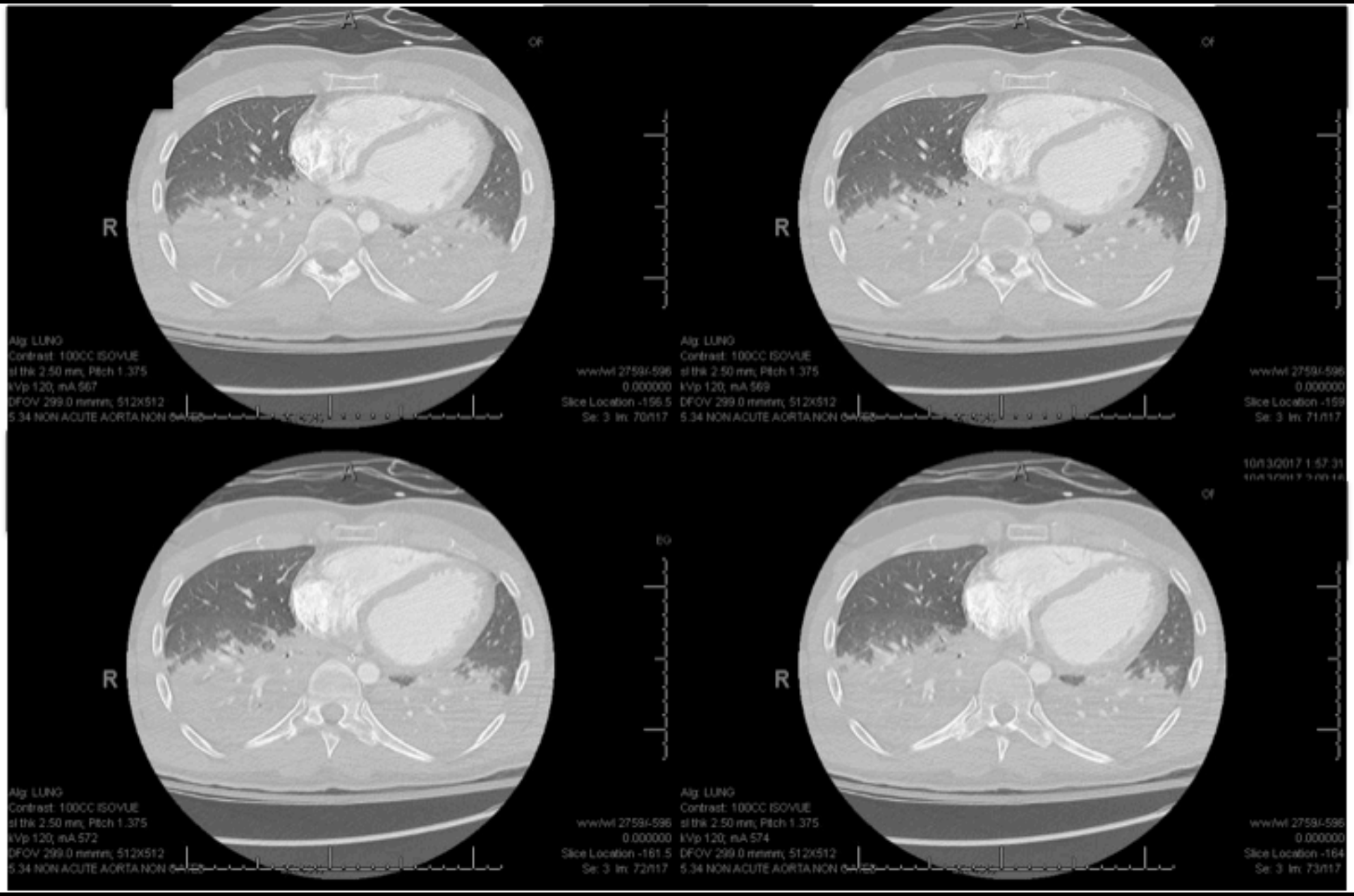
Room 4

Room 4 – 25 yo Male

- 25 M at bowling alley. Palpitations-> collapse. Immediate bystander CPR. VT/VF storm. 9-10 shocks, amiodarone. Here has incomplete BBB
- Troponin not detectable
- K 2.4
- Waking up

Arrival

2 hours later after RIJ


A
R
Alg: LUNG
Contrast: 100CC ISOVUE
sl thk 2.50 mm; Pitch 1.375
kVp 120; mA 567
DFOV 299.0 mmmm; 512X512
5.34 NON ACUTE AORTA NON
ww/wl 2759/-596
0.000000
Slice Location -156.5
Se: 3 Im: 70/117
A
R
Alg: LUNG
Contrast: 100CC ISOVUE
sl thk 2.50 mm; Pitch 1.375
kVp 120; mA 569
DFOV 299.0 mmmm; 512X512
5.34 NON ACUTE AORTA NON
ww/wl 2759/-596
0.000000
Slice Location -159
Se: 3 Im: 71/117
10/13/2017 1:57:31
A
R
Alg: LUNG
Contrast: 100CC ISOVUE
sl thk 2.50 mm; Pitch 1.375
kVp 120; mA 572
DFOV 299.0 mmmm; 512X512
5.34 NON ACUTE AORTA NON
ww/wl 2759/-596
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Slice Location -161.5
Se: 3 Im: 72/117
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R
Alg: LUNG
Contrast: 100CC ISOVUE
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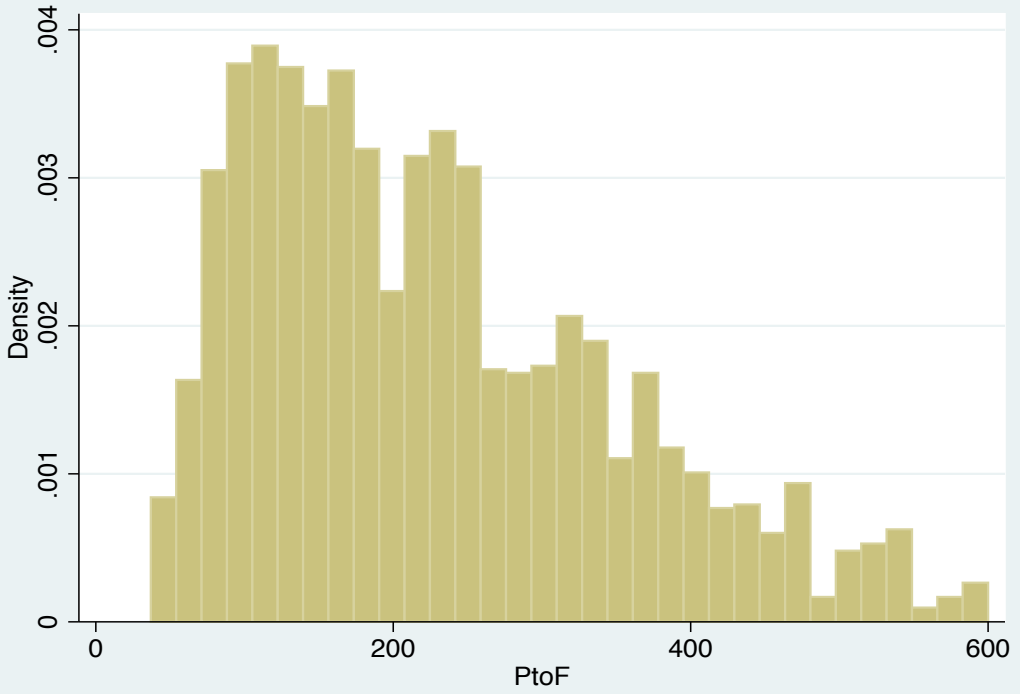
kVp 120; mA 574
DFOV 299.0 mmmm; 512X512
5.34 NON ACUTE AORTA NON
ww/wl 2759/-596
0.000000
Slice Location -164
Se: 3 Im: 73/117

Airway and Ventilator

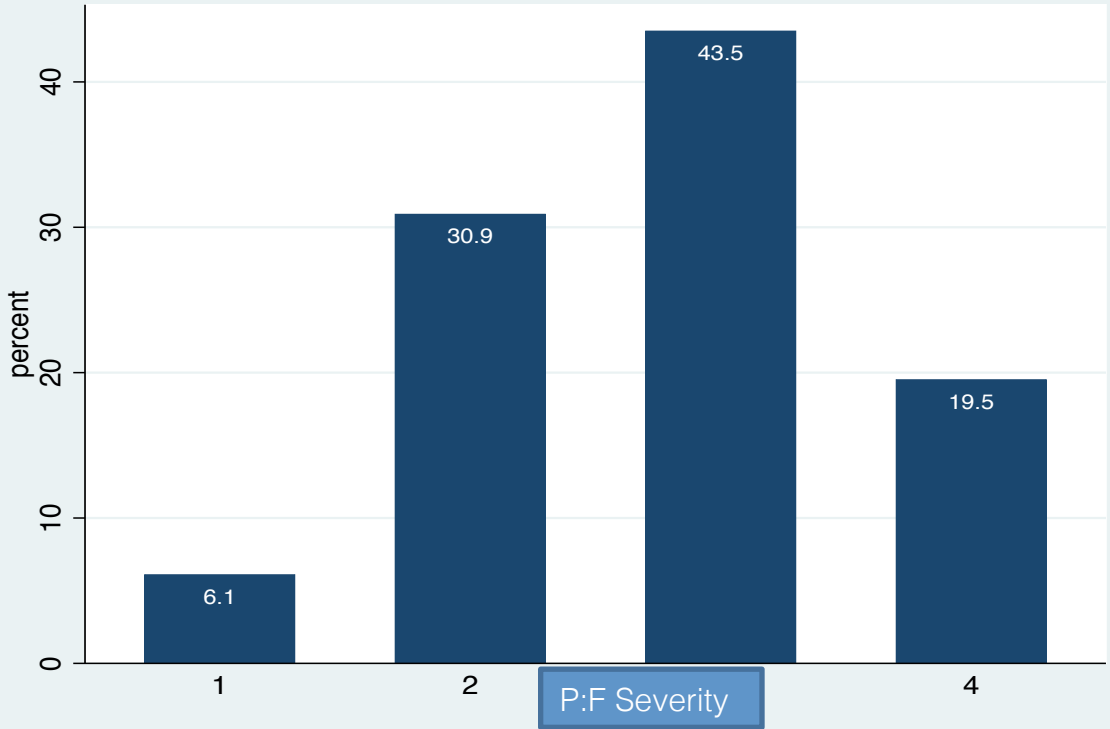
Blood Pressure and Pressors

P:F Ratios

246 patients
Mean P:F: 237
Median per PAD



P:F Ratio

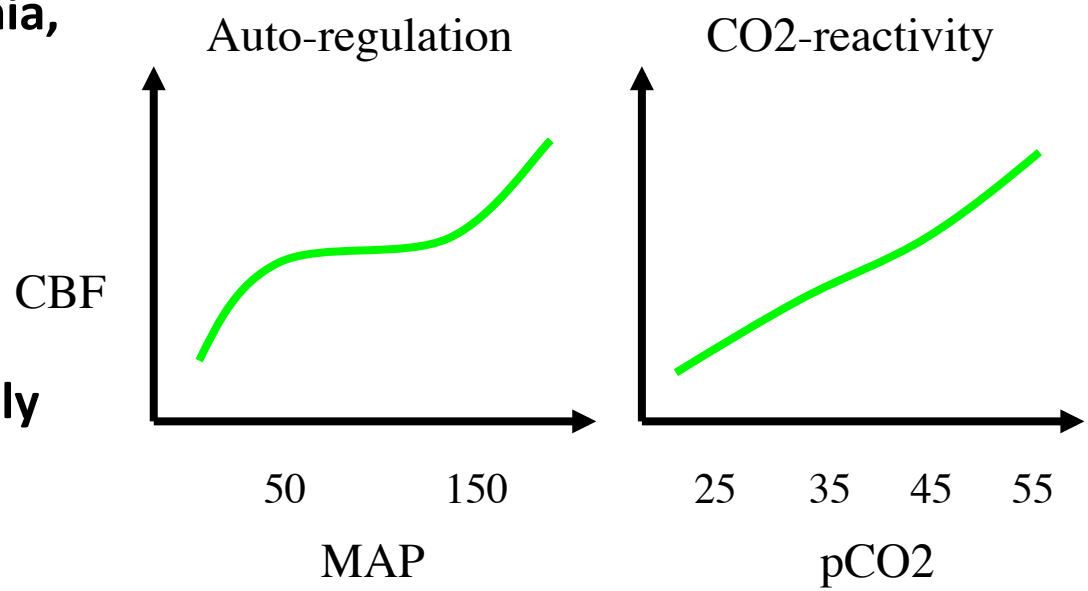


P:F Severity

1=<100 (severe)
2=<200 (mod)
3=<300 (mild)
4=Normal

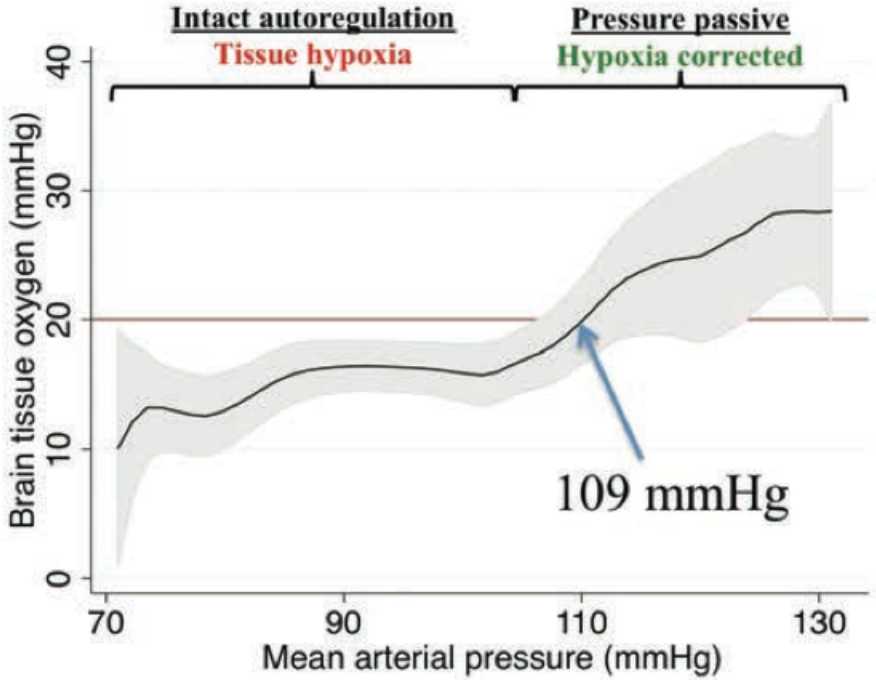
Normal Physiology of Cerebral Blood Flow (CBF)

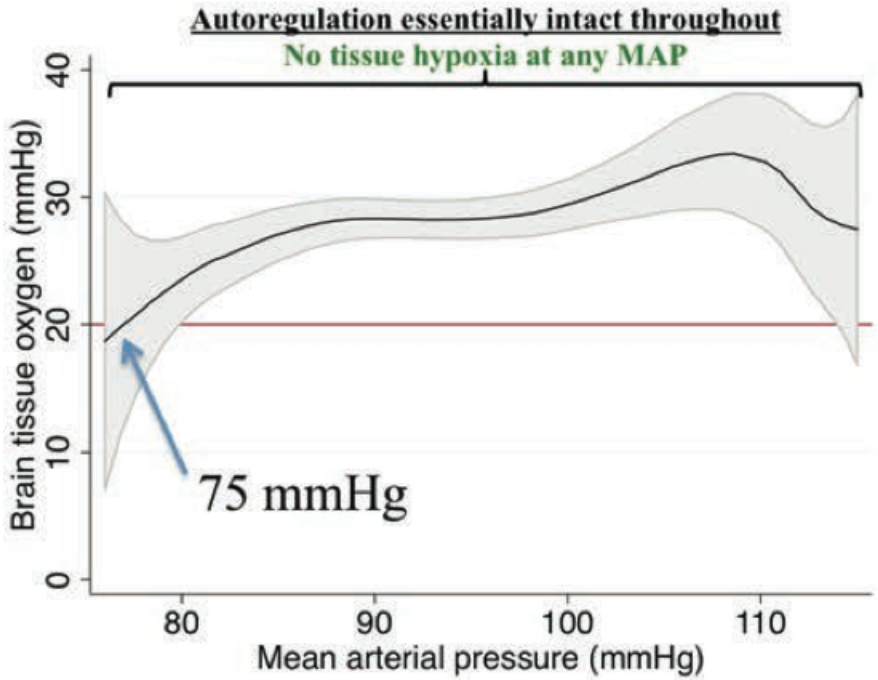
- **Ventilator set to keep eucapnia, normal pH**
  - PCO2 is 35-45 mmHg
  - Hyperventilate
    - get dizzy
  - Hypoventilate
    - head rush
- **Blood pressure can vary widely**
  - MAP is 50-150 mmHg
  - MAP <50 mmHg
    - syncope
  - MAP >150
    - hypertensive emergency

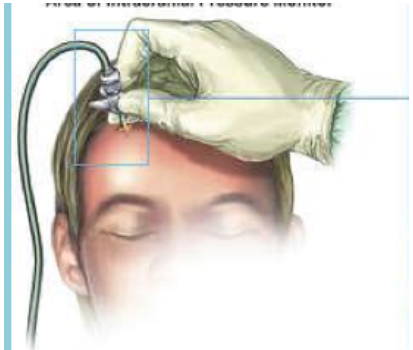


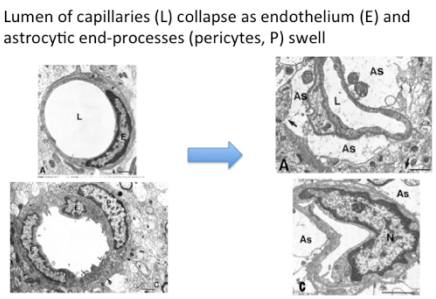
MAP 50-150 mmHg
pCO2 35-45 mmHg

Brain Tissue Oxygen Tension (PbtO2) versus Blood Pressure









Elmer et al. Semin Neurol 2017;37:19–24

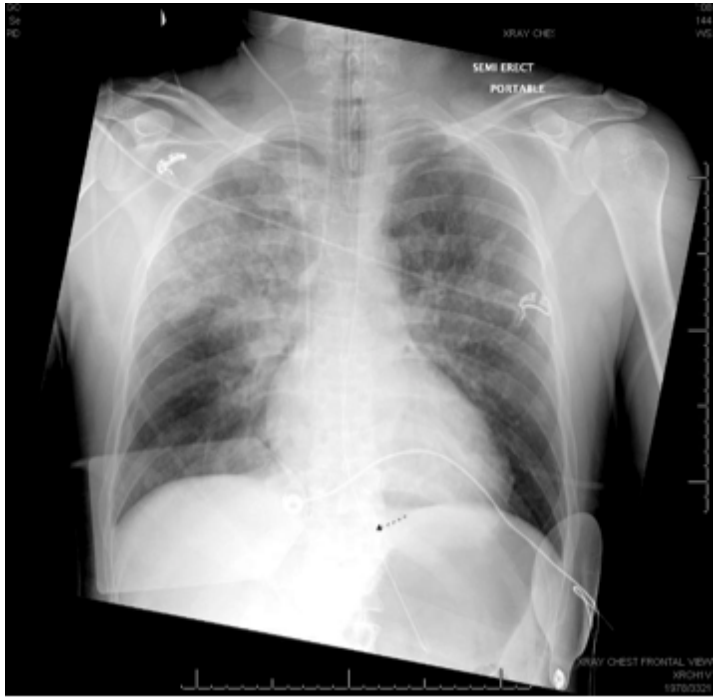
Blood Pressure and Pressors

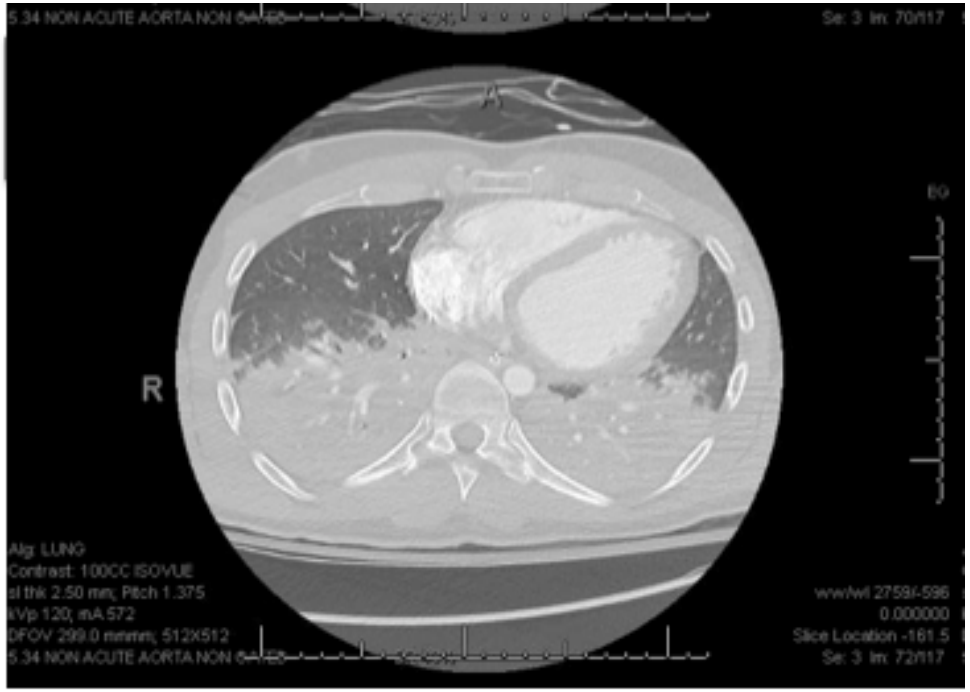
- May look good initially
- “Crumps” over minutes to hours after return of pulses

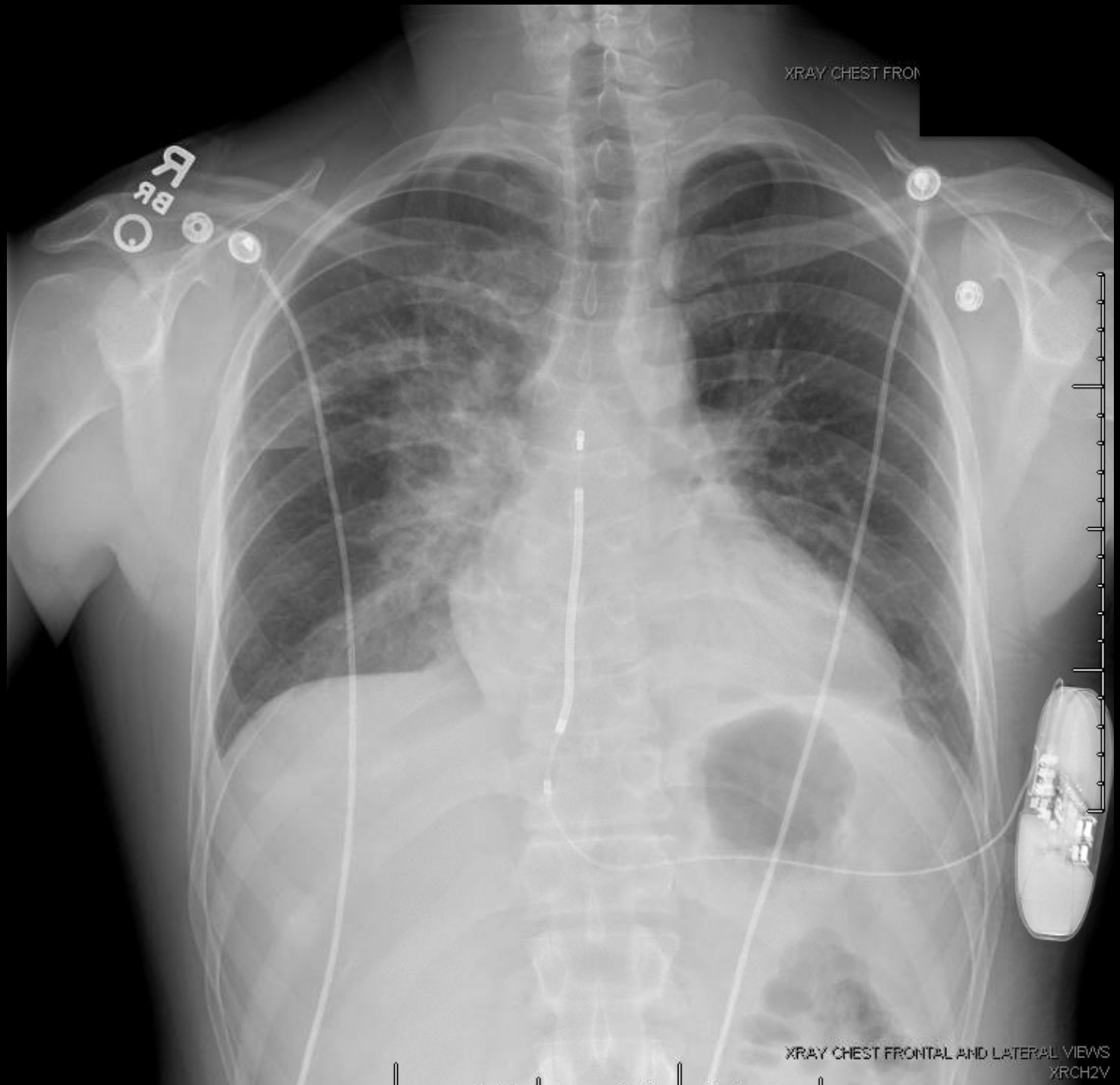
- Goal is to maintain perfusion of brain

ARDS possible over next hours - days

- Minute ventilation ~12-15 lpm
- PaCO2, EtCO2 ~40
- Peak pressures low
- FiO2 – Titrate down based on monitoring
- Antibiotics?






XRAY CHEST FRON
R
XRAY CHEST FRONTAL AND LATERAL VIEWS
XRCH2V

Pearls

- Yes, you do need the arterial line and central venous line now
  - There is a honeymoon shortly after ROSC
  - Arteries constrict and blood pressure sags after 1-2 hours (arterial line will be harder and harder to cannulate)
  - EEG and brain status may require sedation and drug adjustments
  - The number of drips increases over the next 12 hours (often 5-6 pumps running before next sunrise)
  - Blood pressure can drop over 5-10 minute
  - This is the patient where you probably should check ABG, lactate, K every 4-6 hours

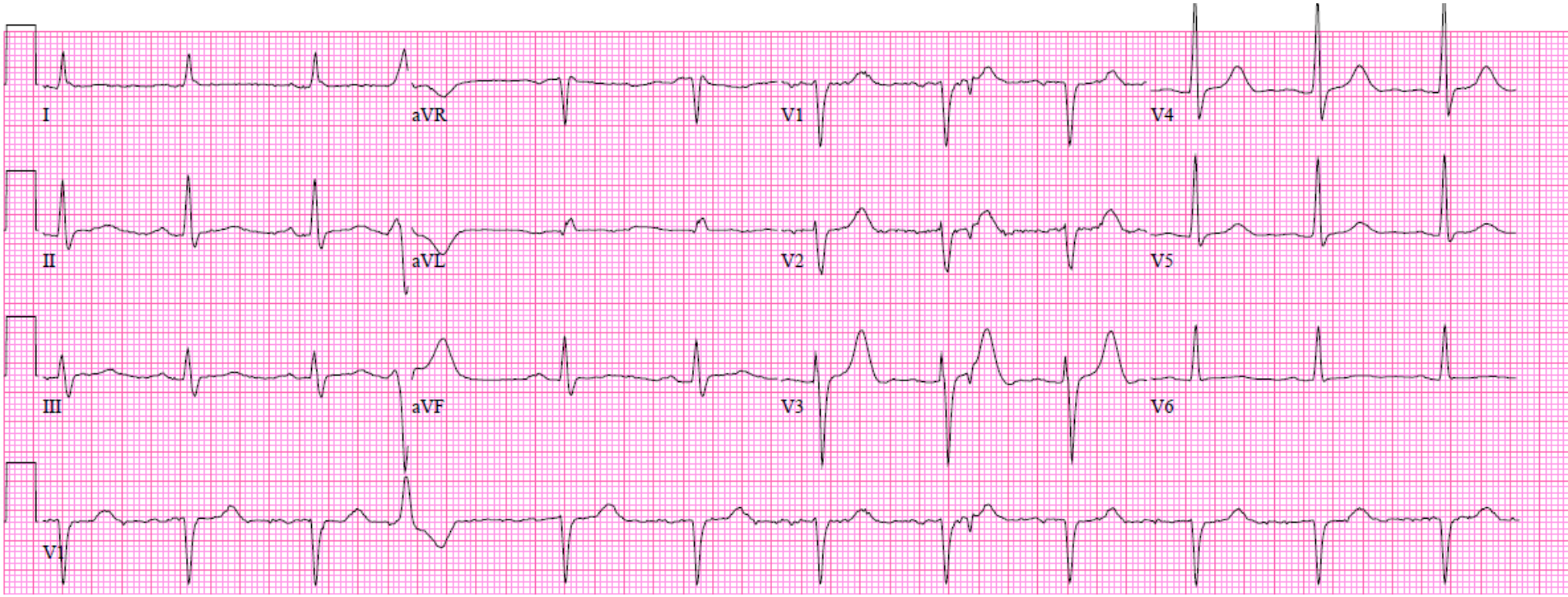
Room 5

Room 5 – in ED

- 68 M w hx htn collapsed on stairwell (7 steps). EMS arrived w AED; shock x 4; Notes from OSH say torsades or VT. Had lots of ectopy at OSH and given lidocaine w resolution.

- Exam: +pupils, corneals, gag, cough, roving eyes. +flex LE. +extension UE.
- CTH Ok. CT trauma OK.
- Replace King airway.

- PCAC?
- Cath lab?
- TTM?



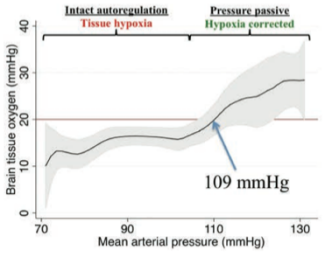
Troponins: <0.04 – 2.3

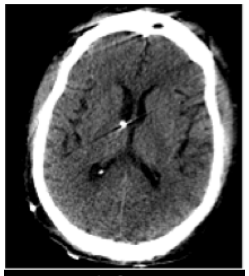
Room 5 – 66 yo male

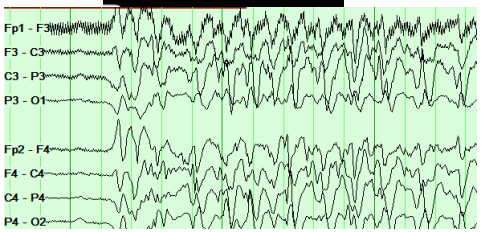
- Trend troponin 2.3 – 7.9 – 4.9 – 4.2
- TTE – LVEF 60%, no FWMA

- TTM to 36ºC, 33ºC, not at all?

33ºC or 36ºC? "Goal-Directed TTM"







Consider 36º

Suspect Brain Hypoperfusion

CT with Cerebral Edema → **Consider 33º**

Epileptiform activity

- *Use temperature to affect specific pathophysiology: cerebral edema, brain tissue hypoxia, seizures*

Room 5 – Hospital Course

- Trend troponin 2.3 – 7.9 – 4.9 – 4.2
- TTE – LVEF 60%, no FWMA
- TTM to 36ºC

- Cath Day 6 – LM 20%; LAD 60%; RCA 95-99%
- RCA – PCI with good TIMI 3 flow

- Extubate ~ day 9
- UTI, Delirium, GI bleed…

- ~ Day 32; Immed recall 3/3. Delayed 0/3. Cannot make change. 0/7 on 41 cent test. Can do some math. Oriented to place, not time. Not yet passed swallow. To IPR

Pearls

- Nobody knows what to do with Non-STE
  - Early cath vs. delayed cath
  - Overall, 25% have treatable CAD
  - When hemodynamically and electrically stable, it is equivocal whether emergency PCI is right

Room 6

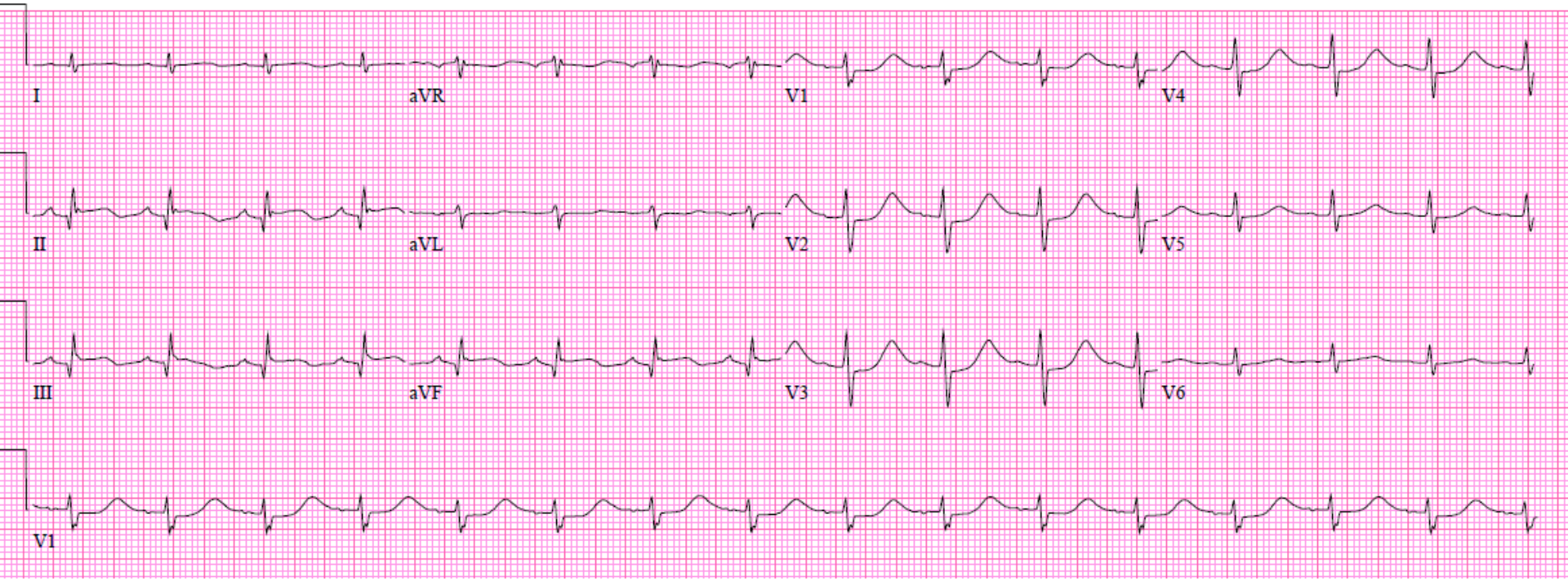
Room 6 – 51 yo Male

- 51 M collapsed while on phone w wife. She called 911 who went to find him in VF. Shock x 5, epi x 4.
- No pressors. 124/85; HR 66; Arrives temp=34
- Exam: +pupil, corneal, gag, cough, oculocephalic, Flexion-withdraw UE. Nothing LE.
- CT head normal.
- Begins to have some "jerks"

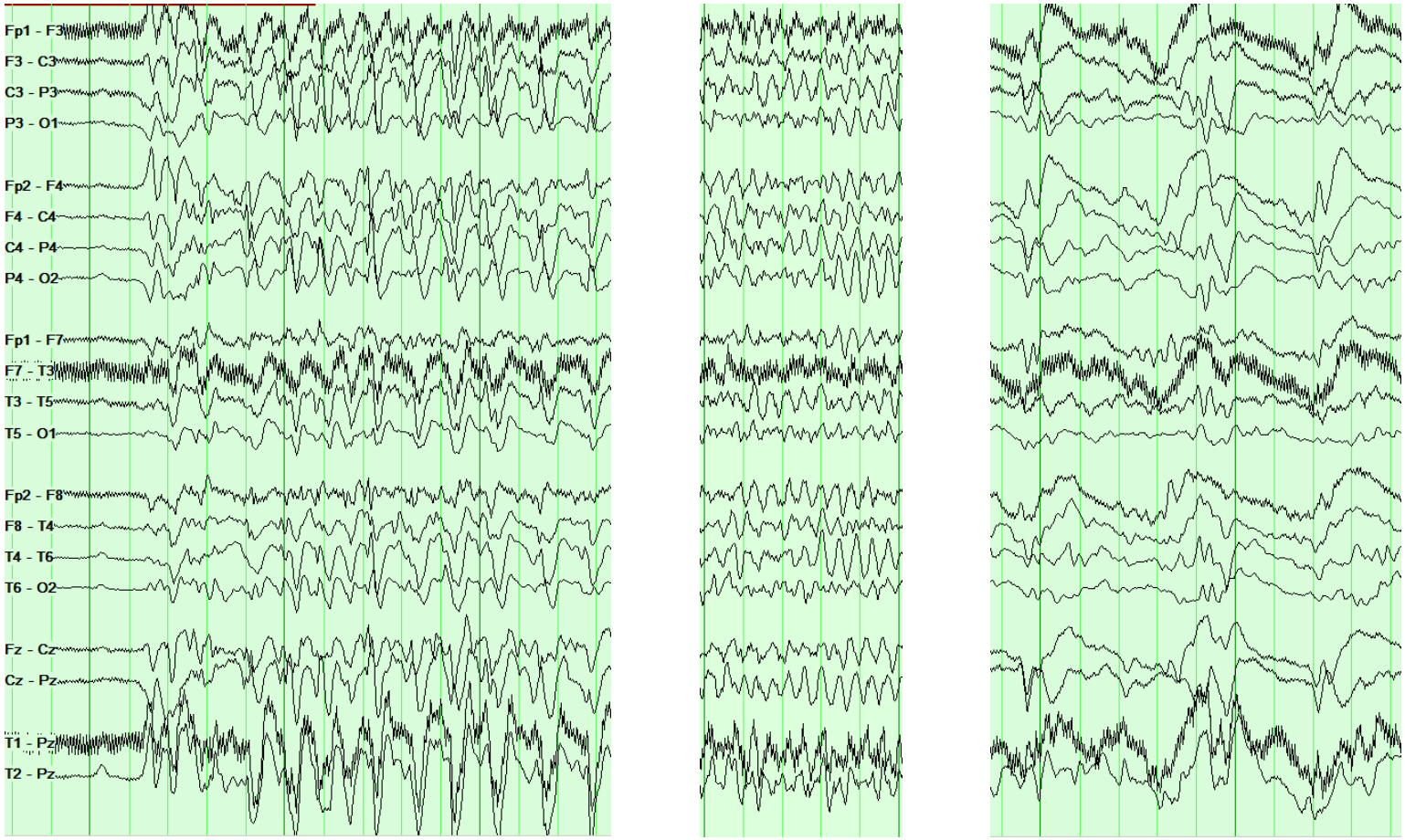
- PCAC?
- Cath Lab?


Portable
XRAY CHEST FRONTAL VIEW
XRCH1V
2219/3579

- Tranthoracic Echo – LVEF 40%; no FWMA
- Troponin – 0.86 – 63.2
- STEMI – To Cath and PCI to OM1 – Good flow
- Troponin – 0.86 – 63.2 – 202 – 66.5



Seizures



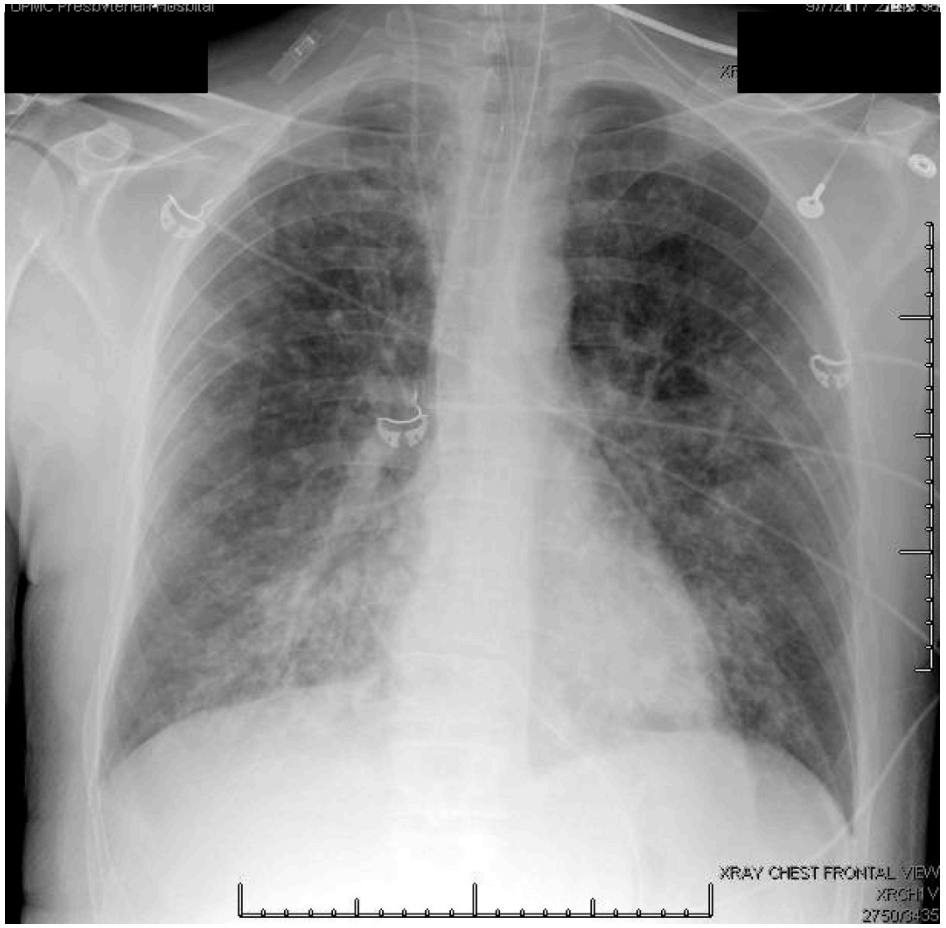
Some respond to treatment

Room 6 – 51 yo Male

- Arrives Temp = 34, so pick TTM 34
- EEG: In NCSE -> keep hypothermic x 48 hrs while titrating anticonvulsant;
- Seizures suppressed after few days

Day 1

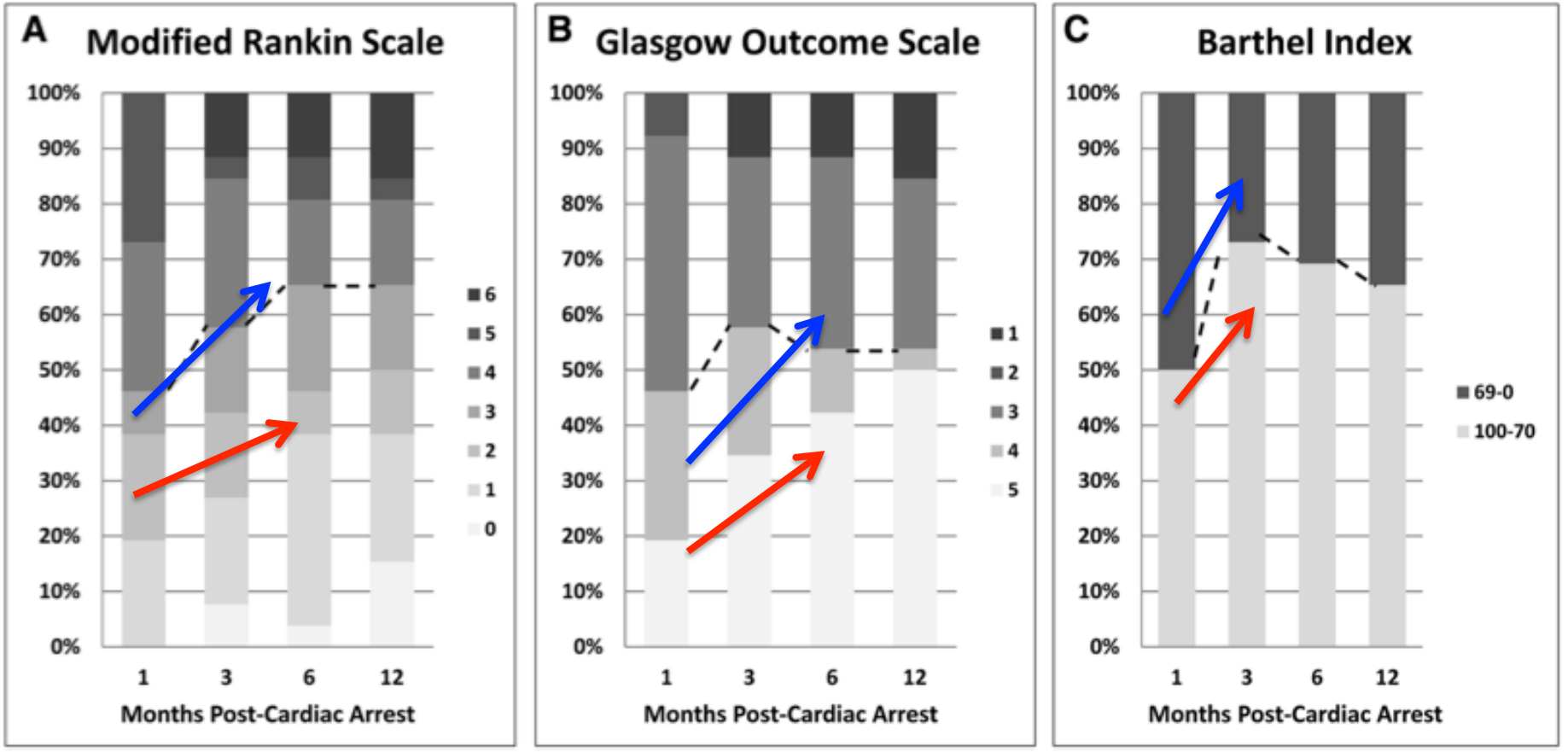
Day 3



Room 6 – 51 yo Male

- Arrives Temp = 34, so pick TTM 34
- EEG: In NCSE -> keep hypothermic x 48 hrs while titrating anticonvulsant;
- Seizures suppressed after few days
- ARDS: prone, paralyze
- Trach ~ day 14;
- Day 31 – to IPR; tracks, intermittently follows commands; perseverates and answers “yup” or “nope” to most questions

Functional Neurologic Outcomes Change Over the First 6 Months After Cardiac Arrest



Crit Care Med 2016; 44:e1202–e1207

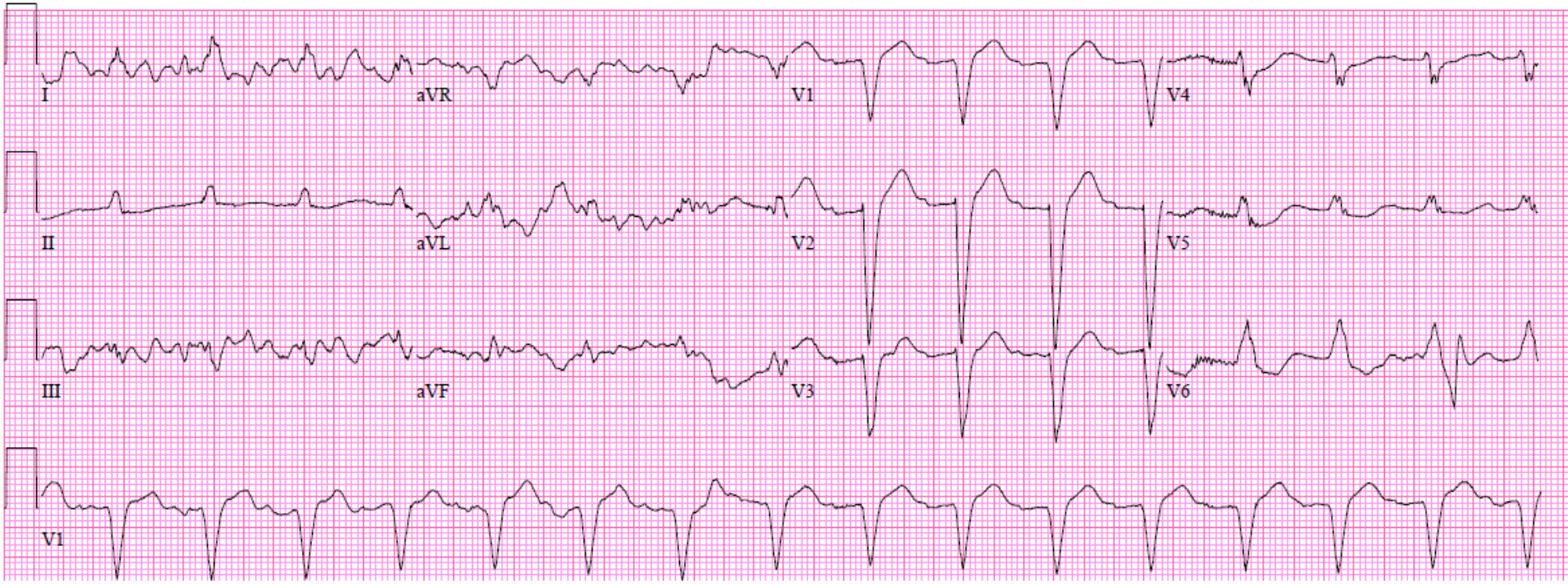
Room 7

Room 7 – 69 yo male

- 69 yo male h/o CABG 2006 had OHCA in bed with wife. EMS found shockable rhythm. Defib/Epi with ROSC. Taken to St Margaret's --> Presby.
- Has been doing well with normal EF on last stress. INR supratherapeutic. Mild acidosis. Off Norepi. Initial temp 37.
- Initially had some myoclonus and only cough.
- Over time, +pupil, +corneal, +cough/gag, +withdrawal.
- CT head normal..
- EKG w BBB

- Etiology?
- Cath lab?
- Prognosis?

- Peak Tn ~ 0.6
- Transthoracic echo without WMA. LVEF ~30%.
- Cath in AM with no new disease. Moderate lesions with patent grafts. No culprit lesion.



17 Categories – Initial Eval

- Acute Coronary Syndrome (ACS)
- Primary Arrhythmia
- Congenital / Structural Heart Disease
- Secondary Arrhythmia (from cardiomyopathies)
- Cardiogenic Shock
- Pulmonary Hypertension / RV Failure

- Other Respiratory Failure (COPD, Asthma, etc.)
- Large Airway Obstruction

- Trauma (several specific entities)
- Non-Trauma Exsanguination (other acute anemia)

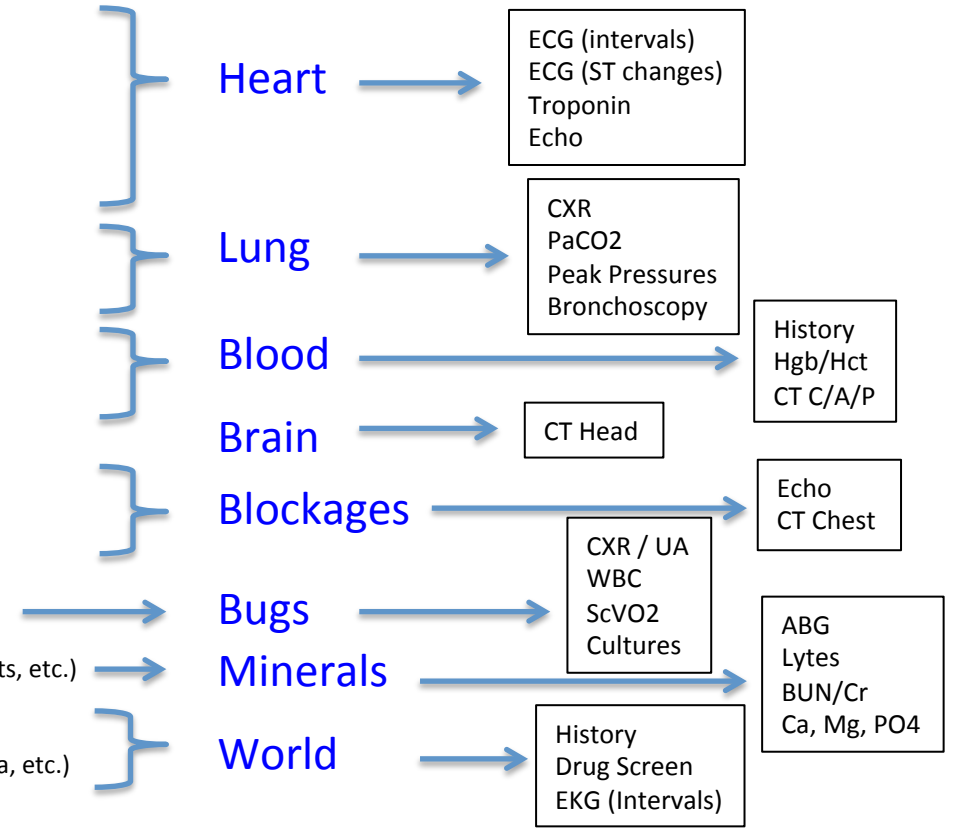
- Catastrophic CNS Event

- Pulmonary Embolus
- Obstructive Shock

- Distributive Shock (sepsis)

- Metabolic Derangements (DKA, other electrolyte shifts, etc.)

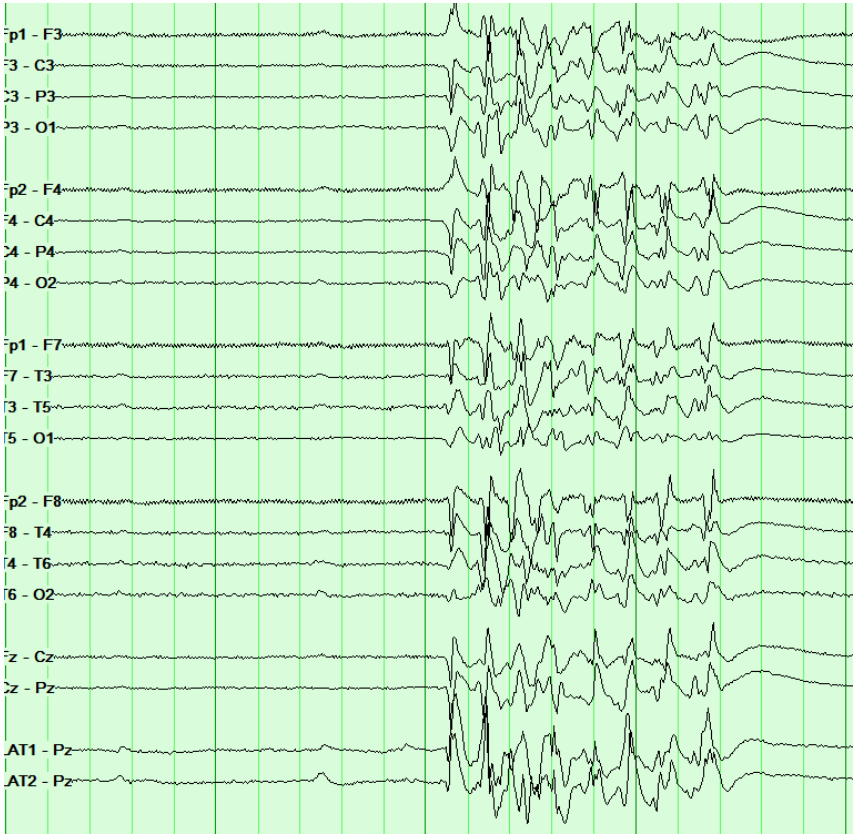
- Toxicological
- Environmental Exposures (electrocution, hypothermia, etc.)



Myoclonic Jerks?

EEG Distinguishes Two Types of Status Myoclonus

Malignant



Lance Adams Variant

Elmer et al., Ann Neurol. 2016; 80: 175-84

Room 7 – Hospital Course

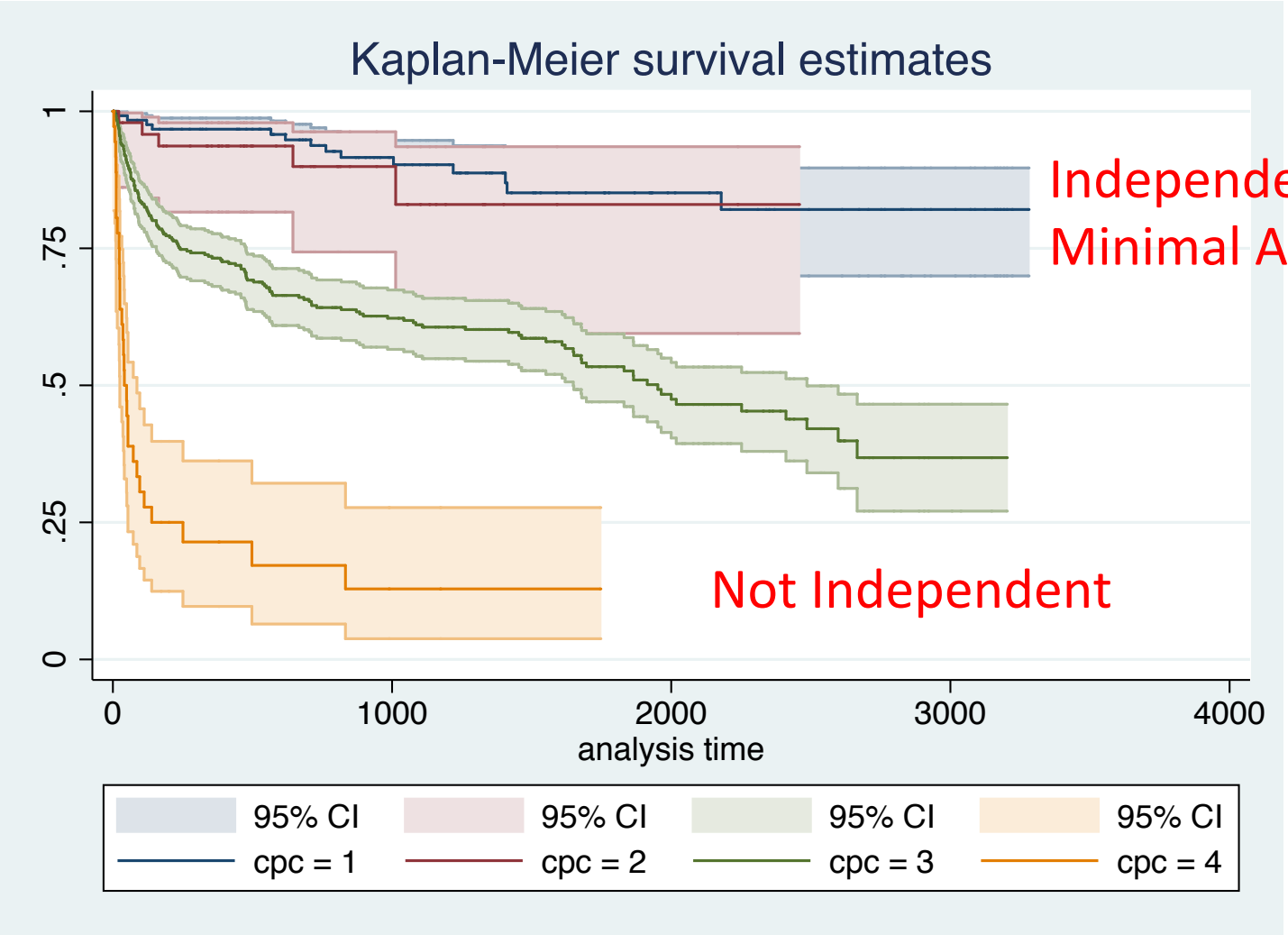
- Extubated ~ day 8
- Delirious x 1 week
- Jerks suppressed w clonazepam
- ICD placed (After get VF strips from EMS)
- To Inpatient Rehab ~ day 16

- Etiology
  - Heart, Lung Blood, Brain, Bugs, Blockages, Minerals, Environment
- Airway and Ventilation
  - Expect pulmonary edema and ARDS (watch pressure)
  - Minute ventilation ~12-15 lpm to start; PaCO2 ~40 mmHg
- Blood Pressure and Pressors
  - Mean pressure 80-100 mmHg
  - Arterial Line for CONTINUOUS monitoring
- Coronary Angiography
  - STEMI (PCAC 1-3, maybe PCAC 4)
  - NSTEMI: story is good; shockable rhythm; focal WMA; rising troponin; unstable
- Temperature Management
  - PCAC 1 – not indicated; PCAC 2-4 – 36ºC
  - Lower (32-33ºC) or longer if cerebral edema, seizures or hypoperfusion of brain
- Prognosis / neuro monitoring
  - CT head, EEG; Expect seizure, brain edema, and treat the treatable ones
  - Later SSEP or MRI if indicated or uncertain

Treat to Minimize Cerebral Edema and Maximize Cerebral Perfusion

- Avoid hypotonic fluids
  - Maintain serum osmolality
  - No rapid decreases in osmolality
  - Fluid neutral or negative over first days
- Elevate head
  - Minimize venous congestion
- Consider specific therapy
  - Hypertonic saline, mannitol
  - Hypothermia
  - ICP- guided intensive care
- Optimal blood pressure
  - Higher is better for brain
  - We pick MAP>80 mmHg
  - Must balance with cardiac function and what is better for heart (higher afterload, better coronary perfusion)

Survival after Hospital Discharge



Elmer 2016, Resuscitation 108:48-53