Shock: Managing the critically ill poisoned patient

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Disclosure

No relevant financial relationships

Toxidromes

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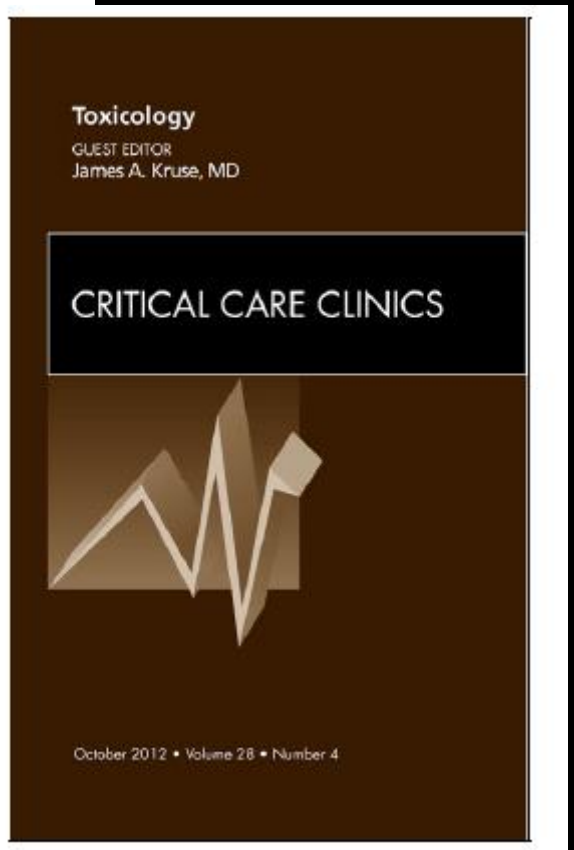
KEYWORDS

• Toxidrome • Syndrome • Poisoning • Toxicology

KEY POINTS

- A toxidrome is a constellation of findings, either from the physical examination or from ancillary testing, which may result from any given poison. It serves to clue the clinician into the correct diagnosis.
- Common toxidromes include: anticholinergic toxidrome, cholinergic toxidrome, opioid toxidrome, sympathomimetic toxidrome.
- Even though these toxidromes can aid the clinician in narrowing the differential diagnosis, care must be exercised to realize the exceptions and limitations associated with each.



Case Example
Drinking in the Dark

- 58 y/o male
- URI with persistent cough
- In the middle of the night he took a large swig of “cough medicine.”
- Acute onset of nausea, vomiting, sweating, profuse diarrhea & tremor
- EMS arrive to find the patient with severe abdominal pain, vomiting, diarrhea, diaphoresis and staggering gait.

Drinking in the Dark

- Awake but slow to answer questions.
- Pupils 2 mm
- P 45, BP 151/85, SaO2 93% on RA
- Diffuse rales
- Hyperactive bowel sounds
- Fasciculations & muscle weakness
- Monitor: no ischemia

What Syndrome?

Drinking in the Dark

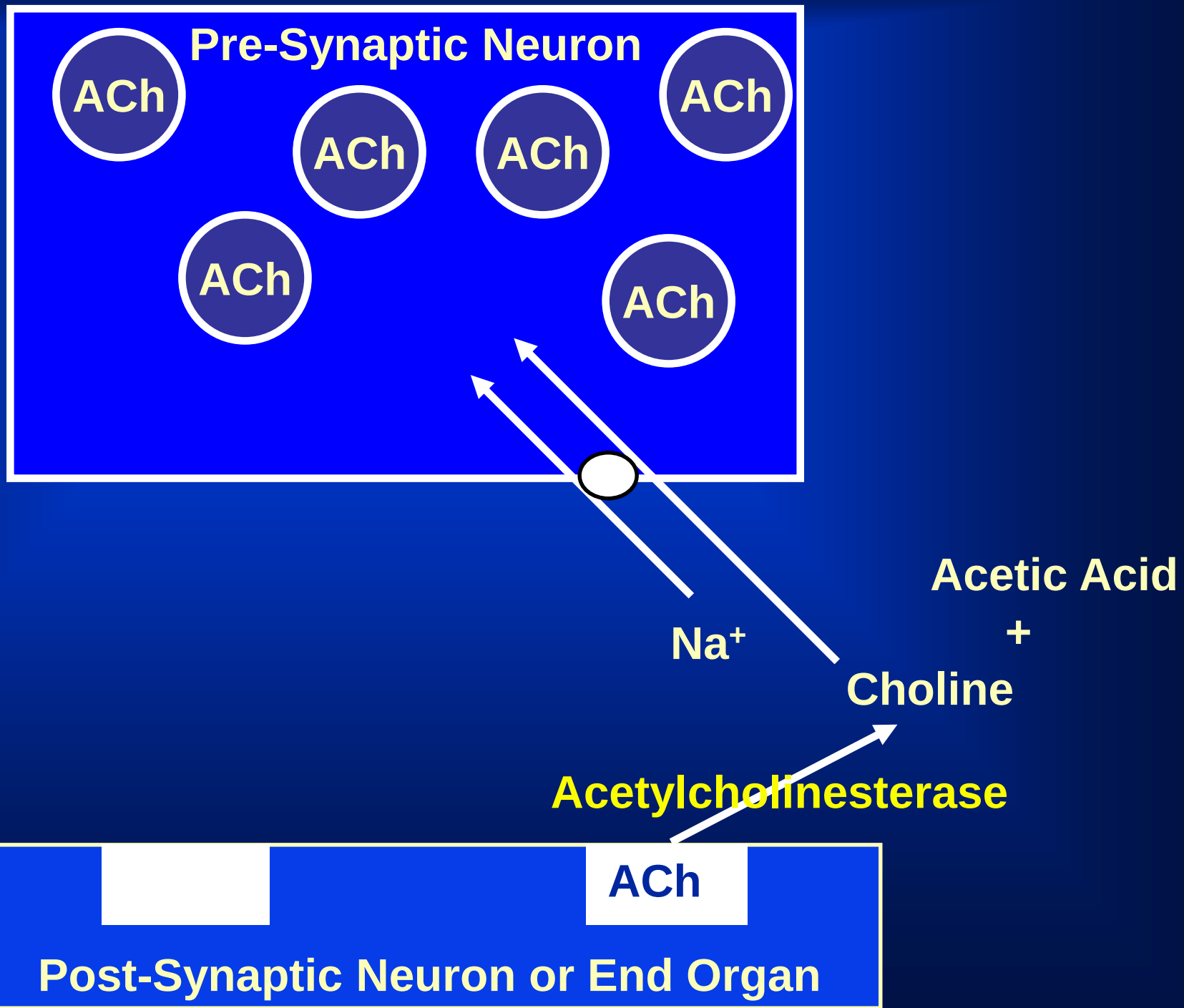
- Awake but slow to answer questions.
- Pupils 2 mm
- P 45, BP 151/85, SaO2 93% on RA
- Diffuse rales
- Hyperactive bowel sounds
- Fasciculations & muscle weakness
- Monitor: no ischemia

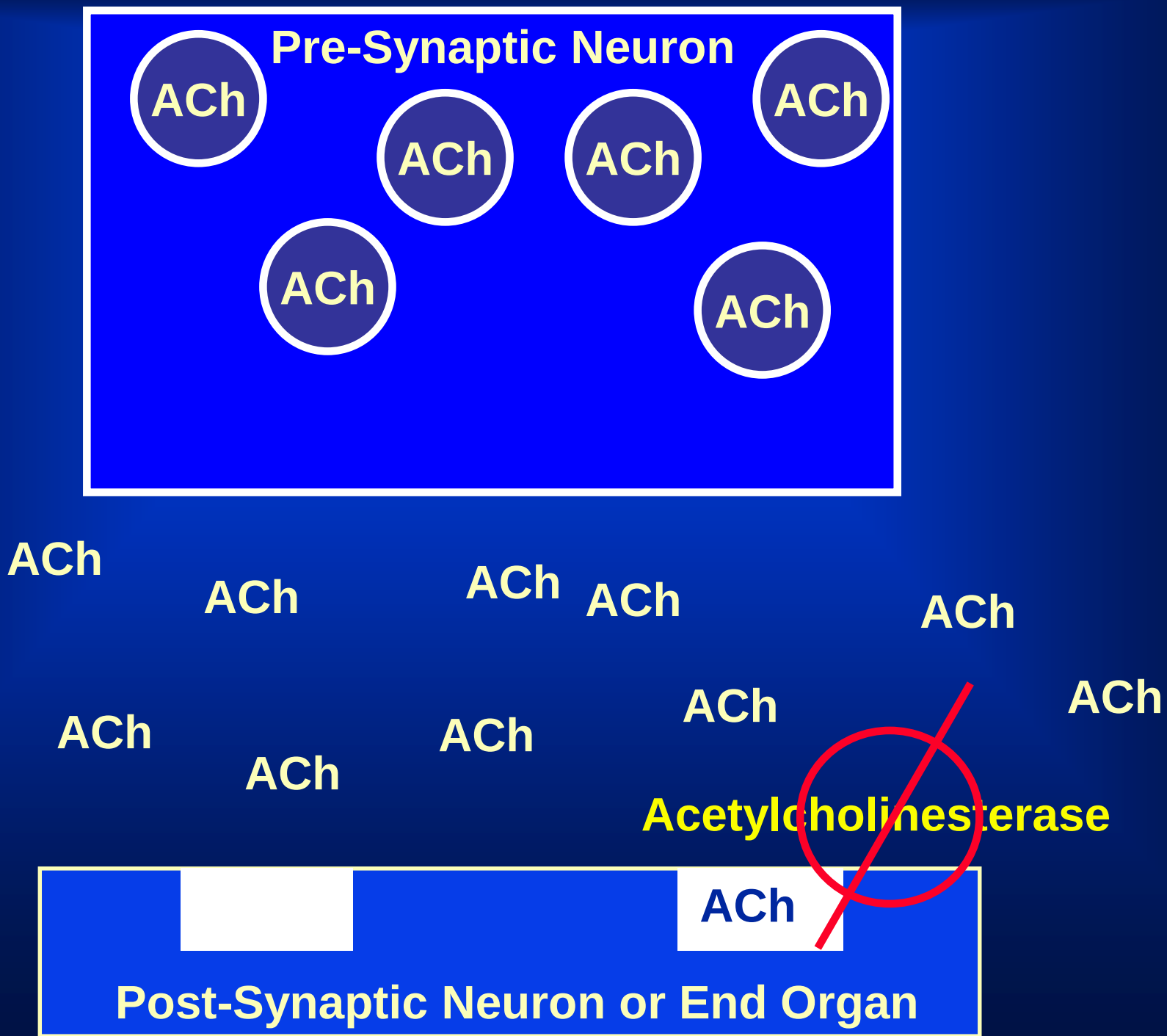
Drinking in the Dark

Progression

- increasing SOB
- RR 36
- diffuse rales
- increased upper airway secretions
- SaO2 85% despite oxygen therapy
- P 120
- Decreasing mental status

What Treatment?


Pre-Synaptic Neuron
ACh
ACh
ACh
ACh
ACh
ACh
Na+
Acetic Acid
+
Choline
Acetylcholinesterase
ACh
Post-Synaptic Neuron or End Organ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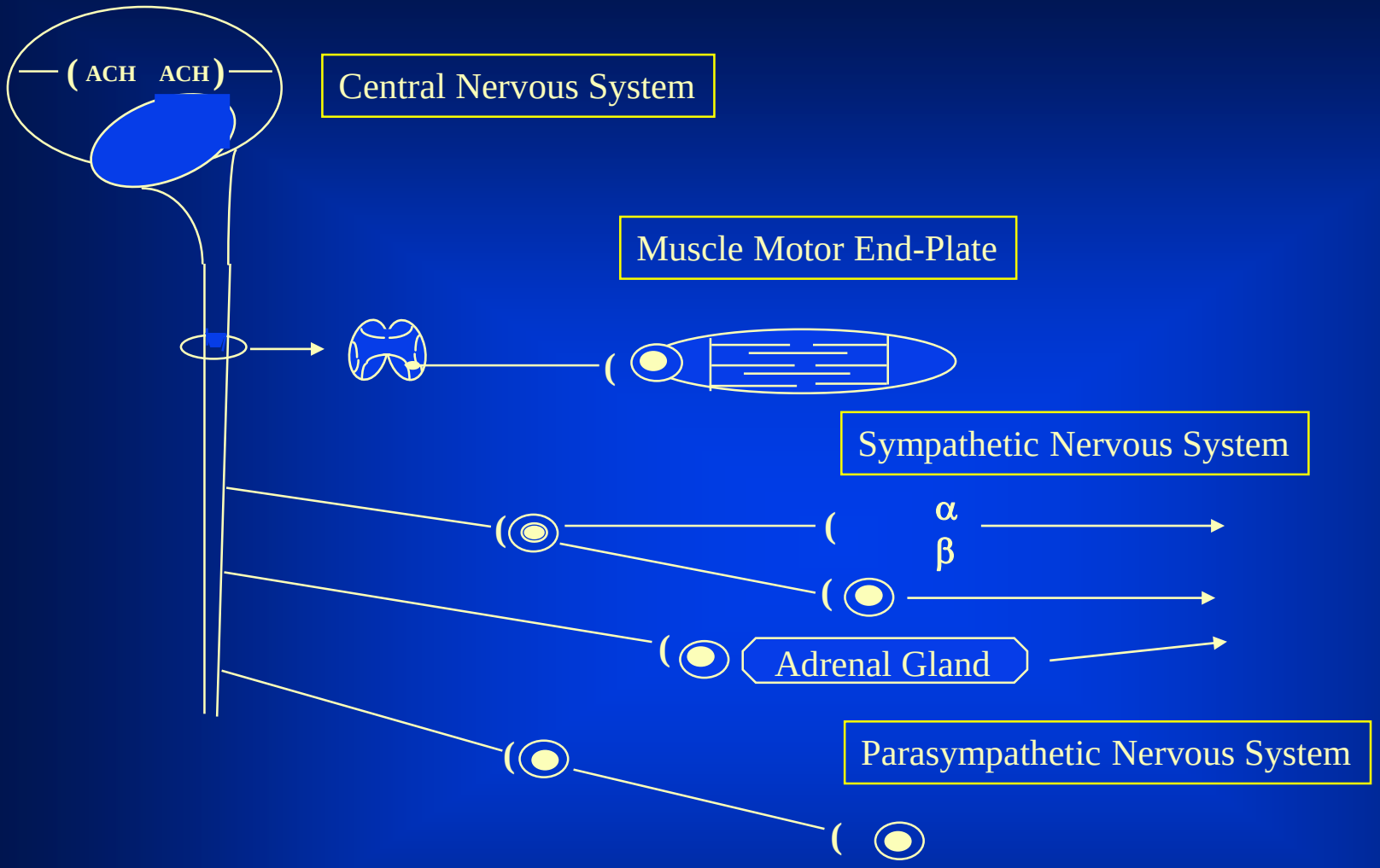


Nervous Syndrome

Cholinergic

DUMB BELS

- Defecation
- Urination
- Miosis
- Bradycardia
- Bronchoconstriction
- Emesis
- Lacrimation
- Secretions

Focused Therapy

- **Decontamination**

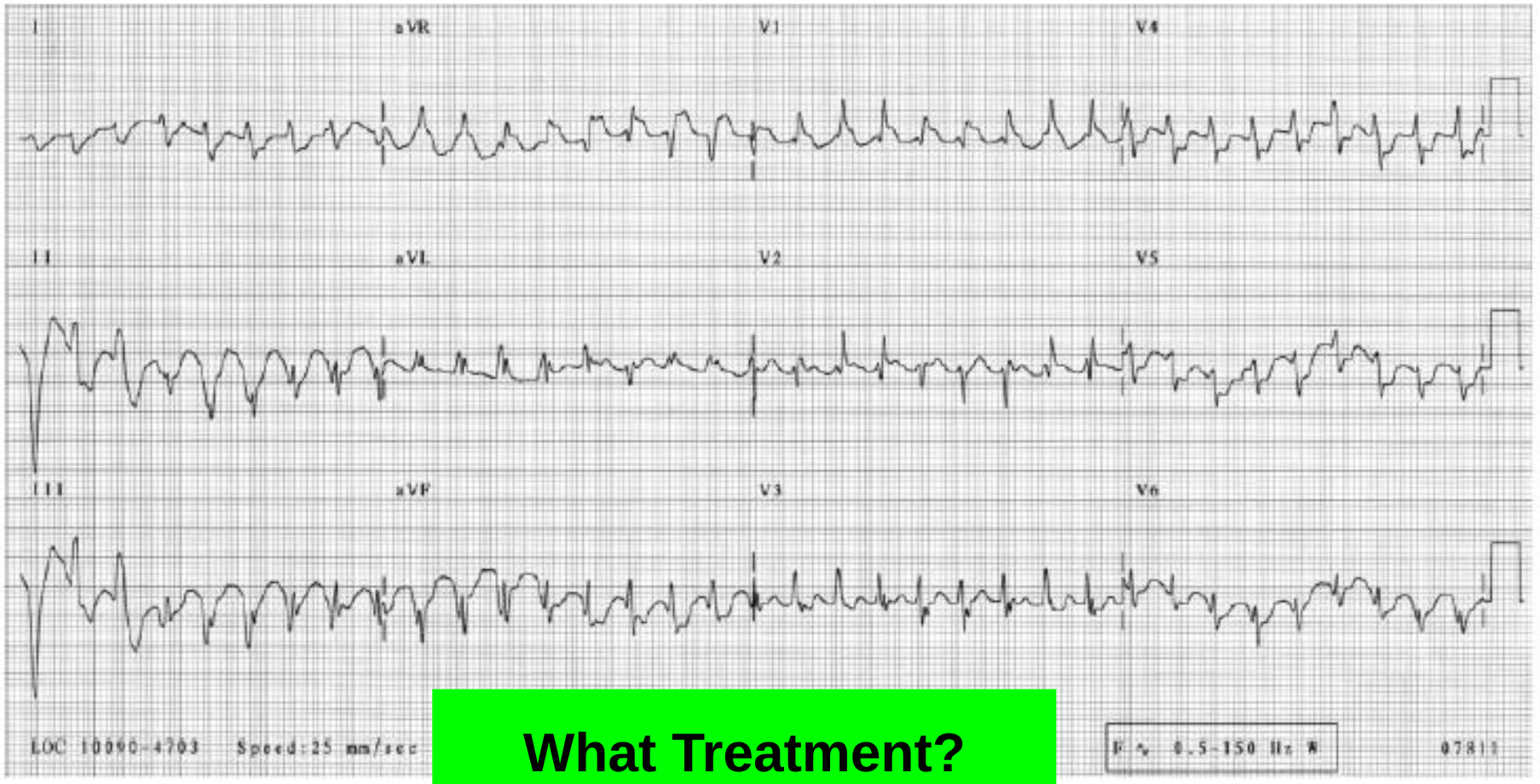
Focused Therapy

- **Atropine**
  - intravenous, intramuscular, endotracheal routes
  - 2.0mg in adults and 0.02mg/kg (minimum 0.1mg) in child
  - tachycardia is not a contraindication to atropine use
  - drying of respiratory secretions is therapeutic endpoint
  - has no effect on ganglia and neuromuscular junctions
  - may be helpful in resolving seizures
- **Pralidoxime**
  - give first dose as rapidly as possible
  - 1.0mg in adults and 15-25mg/kg in child
  - once aging has occurred, it will have no effect
- **Benzodiazepines**

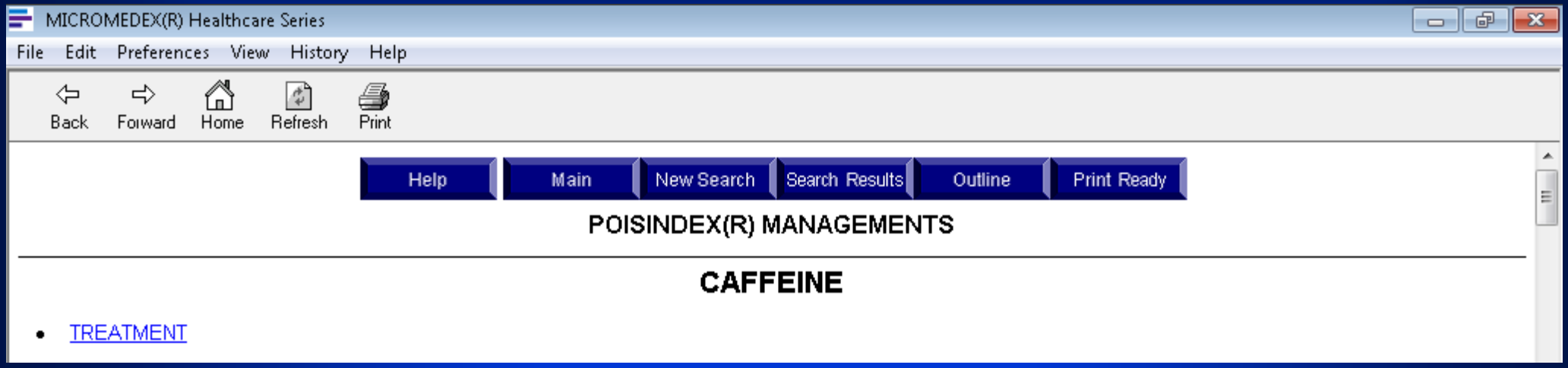
Case Example
Too much caffeine

- A 41 y/o previously healthy, suicidal female presented to the emergency department three hours after ingesting approximately 250 two-hundred-milligram caffeine tablets.
- Arrival vitals: P 206, BP 140/103, RR 24, 97%. HEENT: pupils 3 mm, moist mm
- Heart: tachy; Lungs: CTA
- Her skin was warm with a moist axilla noted.
- She was oriented only to person and place but demonstrated a good speech pattern. She had a resting tremor, hyperreflexia, but no clonus was elicited.

ECG



What Treatment?



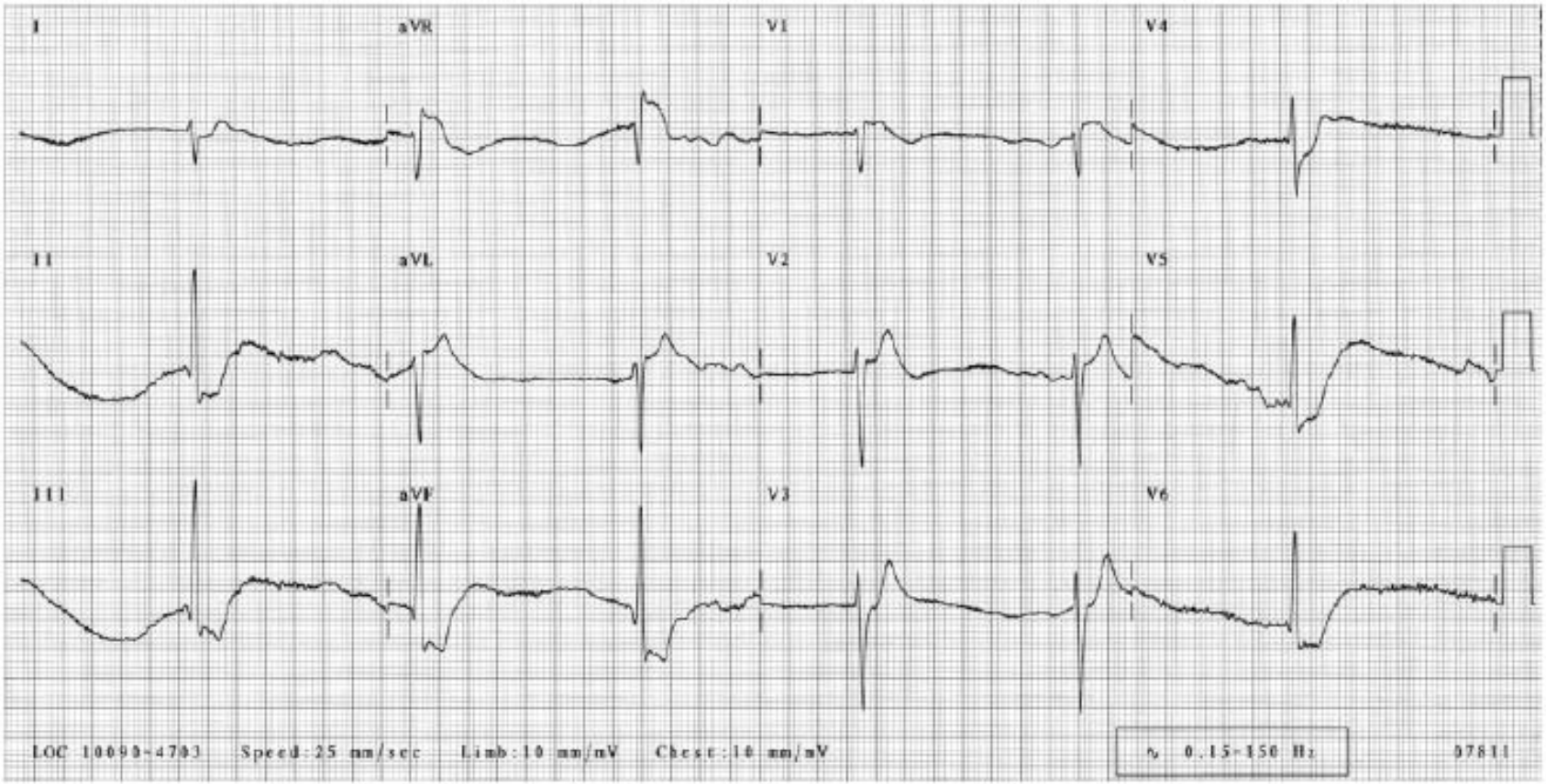
TACHYARRHYTHMIA

- *If severe tachycardia is complicated by hemodynamic instability, beta blockers are the agents of choice in controlling caffeine-induced dysrhythmias. Beta blockers can antagonize both the cardiac and peripheral effects of beta-receptor stimulation caused by caffeine. If beta blocking drugs are used, a short acting cardioselective beta blocker, like esmolol, is advised. Patients have been successfully managed with propranolol.*

Treatment

- 2 IVF liter bolus.
- 4 milligrams of lorazepam
  - No significant effect on mental status or heart rate.
- 5 mg of metoprolol.
  - bradycardic and sustained a 6 sec episode of asystole.
- systolic blood pressure dropped into the 80's but a preserved level of consciousness.
- brief tonic-clonic seizure
- endotracheal intubation.

ECG #2


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
LOC 10090-4703
Speed:25 mm/sec
Limb:10 mm/mV
Chest:10 mm/mV
0.15-150 Hz
07811

Laboratory

- WBC 27.2
- Na 139 mmol/L, K 2.8 mmol/L, Cl 106 mmol/L, bicarbonate 9 mmol/L, glucose 324 mg/L,
- CPK 103 U/L

- Serum caffeine was reported as < 1 mg/L, later corrected to 405 mg/L (1 cup = 2 mg/L).
- Serum theophylline was 12.2 mg/L.

Cardiovascular collapse

- Despite dopamine (20 μg/kg/min), norepinephrine (20 μg/kg/min), and epinephrine (2 μg/kg/min) infusions, a systolic blood pressure by doppler only in the 50's could be maintained.

What Treatment?

Cardiovascular collapse

- Despite dopamine (20 μg/kg/min), norepinephrine (20 μg/kg/min), and epinephrine (2 μg/kg/min) infusions, a systolic blood pressure by doppler only in the 50's could be maintained.
- Vasopressin was begun at 0.2 U/min and advanced to 1.2 U/min in an attempt to maintain sufficient blood pressure for hemodialysis.
- Eventually a systolic blood pressure in the 80's was maintained and hemodialysis was performed
- Dramatic improvement with dialysis

Caffeine
Cardiovascular Effects

3 mechanisms are proposed for the pro-arrhythmic potential of caffeine overdoses:

1) Caffeine increases circulating catecholamines.

2) Caffeine inhibits phosphodiesterase.

- **Increased circulating catecholamines after caffeine overdose increase β1-receptor stimulation.**
- **Stimulation of β1-receptors increases intracellular cAMP by G protein stimulation of adenylate cyclase.**
- **The activity of cAMP is prolonged due to decreased metabolism as phosphodiesterase is inhibited**
- **3) Caffeine blocks cardiac A2 receptors that have been shown to be antiarrhythmic.**

Caffeine
Seizures

Caffeine acts as a non-selective antagonist of adenosine receptors.

- **A1 stimulation results in termination of seizure activity.**
  - **During seizures, adenosine is released from depolarizing neurons as metabolic activity increases. This adenosine stimulates A1 receptors at both pre- and post-synaptic neurons to decrease neurotransmitter release and decrease neuronal depolarization respectively.**
- **A2 stimulation causes cerebral vasodilatation assuring adequate blood flow to the brain during periods of high metabolic demand**

Vasopressin

Vasopressin appears to be an especially suitable pressor for refractory hypotension from caffeine because it inhibits both adenylate cyclase and guanylate cyclase in vascular smooth muscle.

- **V1 vascular receptors are located on vascular smooth muscle and mediate vasoconstriction. This V1-receptor activation mediates vasoconstriction by receptor-coupled activation of phopholipase C and release of calcium from intracellular stores, via the phosphoinositide cascade, and extracellular stores, via calcium channels located on the cell membrane.**
- **V2 renal receptors, which cause the antidiuretic effects of vasopressin, are present in the renal collecting duct system and endothelial cells.**

Vasopressin Dosing

- **GI Hemorrhage**
  - 0.2 to 0.4 units/min by continuous intravenous infusion. Then titrate dose as needed (maximum dose: 0.8 units/minute; if bleeding stops, continue at same dose for 12 hours, then taper off over 24 to 48 hours.
- **Diabetes Insipidus**
  - 5 - 10 units intramuscularly or subcutaneously 2 to 4 times a day. Continuous IV infusion: 0.0005 units/kg/hour; double dosage as needed every 30 minutes to a maximum of 0.01 units/kg/hour.
- **Cardiovascular Resuscitation**
  - 40 units intravenously once, followed by 20 mL of normal saline. If spontaneous circulation is not restored within 3 minutes, another 40 units may be given intravenously.

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CASE REPORT

Massive Caffeine Overdose Requiring Vasopressin Infusion and Hemodialysis[#]

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ABSTRACT

Introduction. Massive caffeine overdose is associated with life-threatening hemodynamic complications that present challenges for clinicians. We describe the highest-reported serum concentration of caffeine in a patient who survived and discuss the first-reported use of vasopressin and hemodialysis in a caffeine-poisoned patient. *Case Report.* A 41-yr-old woman presented 3 h after ingesting approximately 50 g of caffeine. She subsequently underwent cardiopulmonary resuscitation and received multiple medications in an attempt to raise her blood pressure and control her heart rate without success. Vasopressin infusion increased her blood pressure to the point where hemodialysis could be performed. Despite ensuing multisystem organ failure, she survived and has made a complete recovery. *Conclusion.* Hemodialysis and vasopressin infusions may be of benefit in the management of caffeine-intoxicated patients who fail to respond to standard therapies.

Northumbria University 'life-threatening' caffeine test fine

25 January 2017 | Tyne & Wear

Share

Northumbria University has more than 30,000 students and a budget of nearly £250m

A university has been fined after two students suffered "life-threatening" effects when they were given 100 times too much caffeine in an experiment.

- Sports science students were each given the equivalent of 300 cups of coffee.
- They were admitted to intensive care for dialysis.
- Prosecutor Adam Farrer told the court the overdose "could easily have been fatal".
- Peter Smith, defending, said the university wished to "emphasize that they take the welfare of their students and staff seriously". 'Not experienced enough'
- The students had volunteered to take part in a test in March 2015 aimed at measuring the effect of caffeine on exercise.
- They were given 30g of caffeine instead of 0.3g.
- They had switched from using caffeine tablets to powder.
- "The staff were not experienced or competent enough and they had never done it on their own before."
- The calculation had been done on a mobile phone, with the decimal point in the wrong place.
- Both men have made a full physical recovery, though one had reported short-term memory loss, the court heard.

Case Example
Don’t Drink Unknown Liquids

- 47 y/o male accidentally ingested a blue liquid he thought was a sport drink.
- He immediately noted throat irritation. Within 5 min of the ingestion, N/V.
- He calls EMS one hour later with a complaint of nausea, weakness, and intense pleuritic chest pain.
- Vital signs revealed on arrival: P 130 beats/min, BP 102/66 mmHg, RR 20 breaths/min.

Case

- His voice was hoarse and he had difficulty swallowing his secretions.
- Oropharynx - eyrthema
- Lungs - diffuse rhonchi
- Heart - tachycardia
- Abdomen was soft with mild tenderness diffusely and audible hyperactive BS.
- His skin was warm and diaphoretic.
- He was alert, orientated, and demonstrated good strength throughout without tremor or clonus.

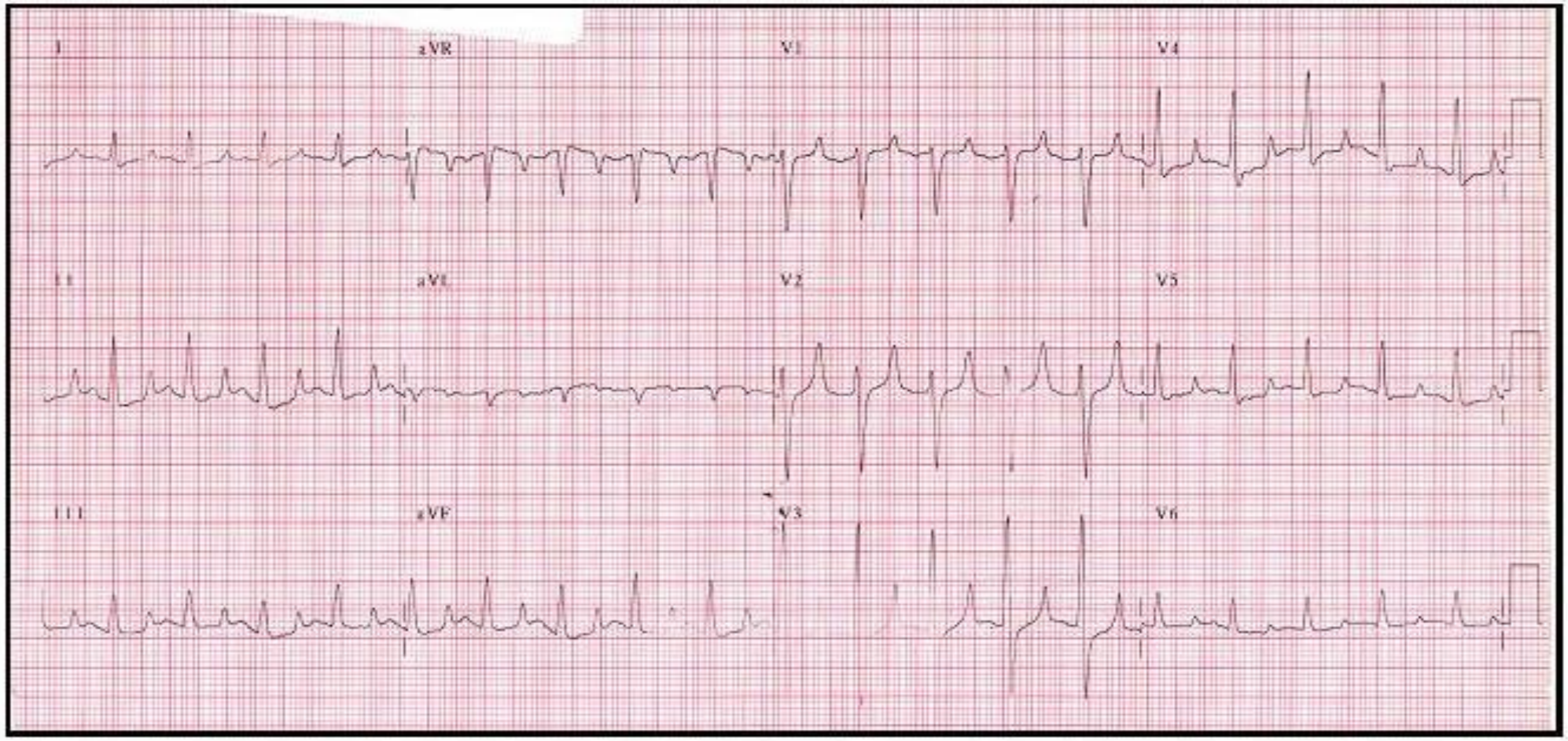

Figure 1

Case

- During transport, he became increasingly agitated and his systolic blood pressure dropped to 80.

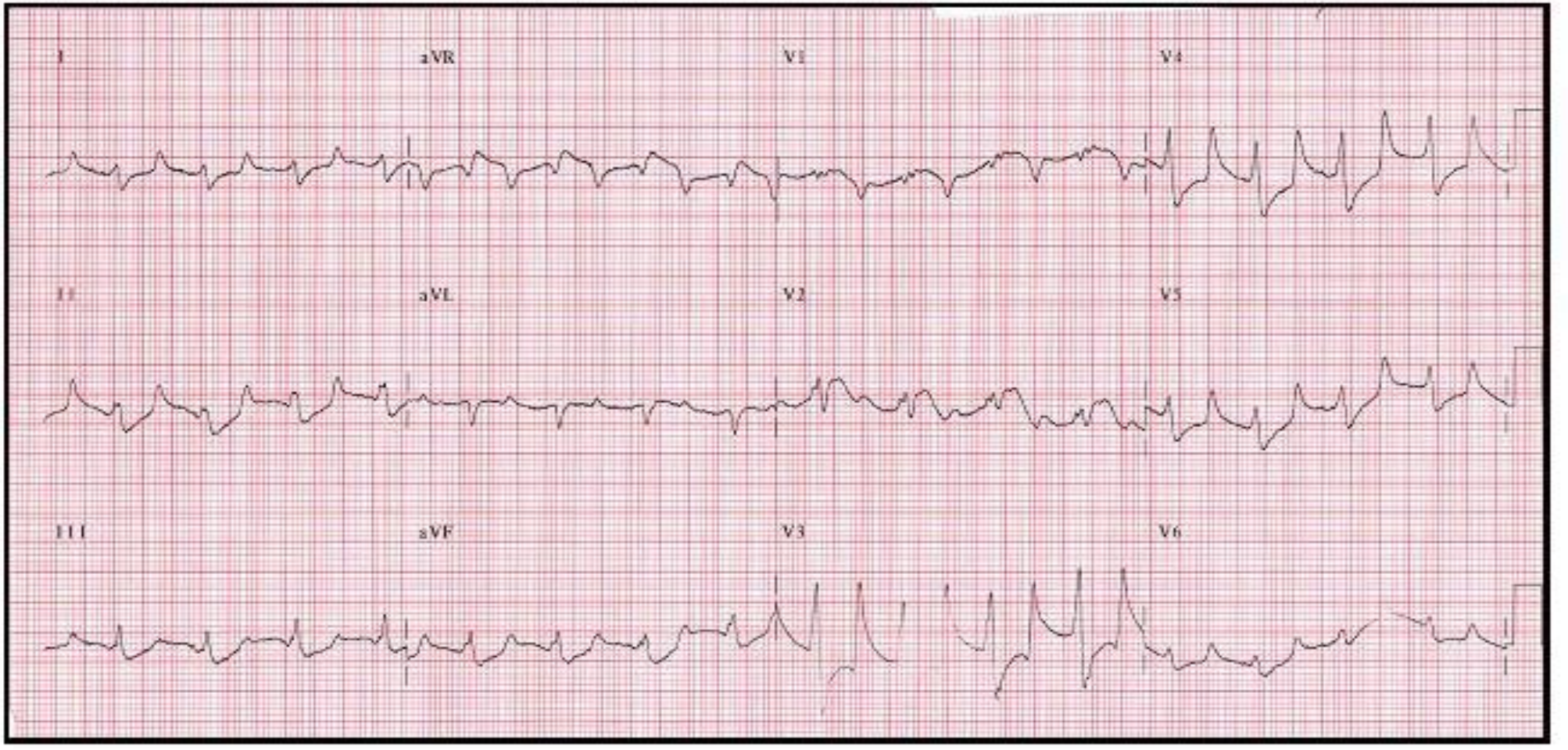

Figure 2

Case

- A repeat ECG (Figure 2) showed an increased widening of the QRS complex to 152 ms, a QTc interval of 742 msec, and further peaking of the T waves.
- Initial bedside evaluation of the ingested fluid by litmus paper revealed a pH less than 4.0.

What Treatment?

Case

- Based upon the apparent caustic nature of the ingestion with an acidic pH and electrocardiographic abnormalities suggestive of calcium and potassium effect, hydrofluoric acid ingestion was suspected.
- The patient received intravenously 4 grams of calcium gluconate, 4 grams of magnesium sulfate, 2 grams of calcium chloride, and 200 meq of sodium bicarbonate over the ensuing 30 minutes.
- His blood pressure increased to 158/94 with associated QRS complex narrowing to 102 ms (Figure 3).

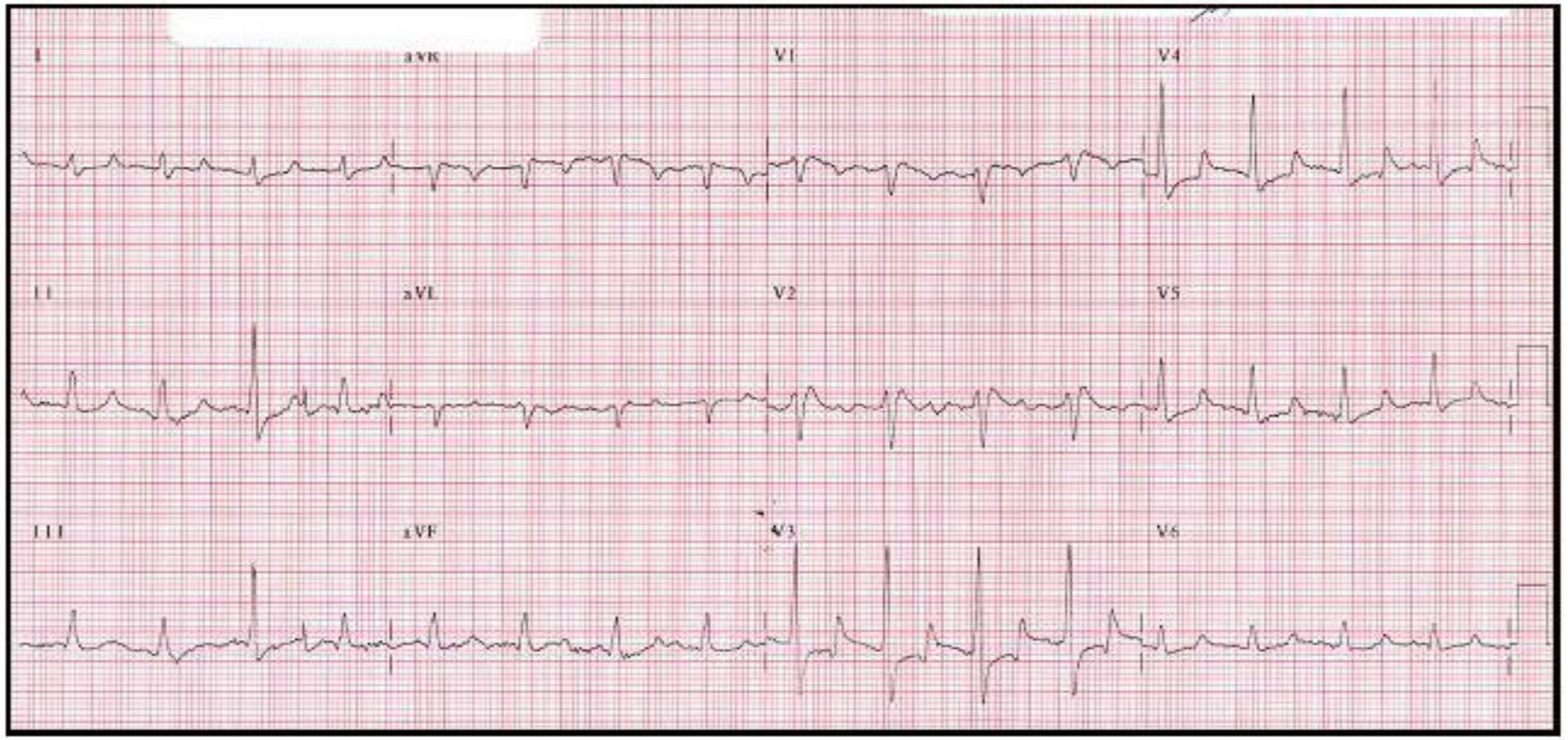

Figure 3

Laboratory

- Initial laboratory values, drawn upon the patient's arrival, were remarkable for:
- Na 138 mmol/L, K 5.7 mmol/L, Cl 103 mmol/L, bicarbonate 12 mmol/L, BUN 10 mg/L, Cr 1.4 mg/L, glucose 193 mg/L, pH 7.28
- Ca < 4.0 mmol/L, Mg 0.7 mmol/L

Outcome

- Over 12 hours, he received a total of 2 gm calcium gluconate, 7 gm calcium chloride, 10 gm $MgSO_4$ and 400 meq of $NaHCO_3$.
- The patient ultimately was discharged after a 21-day hospitalization complicated by GIB, pneumonia, tracheal stenosis requiring placement of a tracheaostomy, and pulmonary embolism requiring placement of an inferior vena cava filter.
- Further laboratory evaluation of the ingested liquid revealed a pH of 0.8. The fluid was identified as hydrofluoric acid through flame ionization and atomic absorption.

American Journal of Emergency Medicine (2005) 23, 171–176

ELSEVIER

The American Journal of Emergency Medicine

www.elsevier.com/locate/ajem

The electrocardiographic toxidrome: the ECG presentation of hydrofluoric acid ingestion

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Abstract The clinician can approach the poisoned patient using the toxidrome system of toxin identification; this approach makes use of findings noted on the physical examination, highlighting the importance of abnormalities in blood pressure, heart rate, respiratory effort, body temperature, mental status, pupillary size, skin color, diaphoresis, and gastrointestinal sounds. Such a method provides structure and guidance to the clinical evaluation, providing the clinician with rapid diagnostic information and suggesting urgent management issues. A case of hydrofluoric acid poisoning is used as an example of this diagnostic approach. The patient demonstrated systemic toxicity accompanied by oral irritation and electrocardiographic abnormality (QRS complex widening and QT interval prolongation). The constellation of these findings suggested the possibility of a caustic agent (history and examination) with potential effect on potassium and calcium metabolism (electrocardiographic abnormalities). Such a constellation strongly suggested hydrofluoric acid as the culprit toxin.

1. Introduction

The clinician can approach the poisoned patient using the toxidrome system of toxin identification. Such a method provides structure and guidance to the clinical evaluation, providing the clinician with rapid diagnostic information and suggesting urgent management issues. The toxidrome method emphasizes the use of the physical examination, highlighting the importance of abnormalities in blood

We present a case of hydrofluoric acid poisoning which initially presented as an unknown ingestion. The patient demonstrated systemic toxicity accompanied by oral irritation and electrocardiographic abnormality (QRS complex widening and QT interval prolongation). The constellation of these findings suggested the possibility of a caustic agent (history and examination) with potential effect on potassium and calcium metabolism (electrocar-

Case Example
Forensic Cases Abound

- **911 call & EMS**
  - **Received 23:52**
  - **Dispatched 23:56**
  - **At Ref: 00:04**
  - **Leave Ref: 00:18**
  - **At Rec: 00:20**
- ***00:09 – HR 106; BP 40; SpO2 92; LOC Unresponsive; Resp 12; Resp Effort Grunting***
- ***00:19 – HR 86; BP 40; SpO2 98; LOC Unresponsive; Resp 12; Resp Effort Normal***

Case – ED

- **00:21 arrival**
- ***41 y/o female with no PMH seen normal at hospital one hour prior to arrival.***
- ***Unresponsive with eyes open.***
- ***Vitals: RR 4, P 44, BP 48/36***
- ***Lungs: Clear with barely audible air movement***
- ***Pupils: 7 mm and nonreactive***

Case - ED

- *Intubated with a 7.5 endotracheal tube*
- *2 peripheral large bore IVs*
- *Atropine, IVF, Epi*
- *Levophed drip*
- *CT head - negative*
- *CT angiogram of the chest, abdomen and pelvis demonstrated only extensive patchy airspace disease and a ground-glass densities suggestive of aspiration*

Case - ED

- *pH 6.85, pCO2 26, pO2 553, bicarbonate 4.*
- *Na 136, K 3.2, Cl 108, HCO3 6, BUN 13 Cr 1.2, glucose 259, SGPT 36, SGOT 181*
- *Troponin neg*
- *EKG: sinus bradycardia at 57, PR interval 160 milliseconds, QRS duration 112 milliseconds, QTC 393 milliseconds.*

Case - Lactate

- 04-18-2013 @ 0007 – 16.5
- 04-18-2013 @ 0200 – 17.0
- 04-18-2013 @ 0250 – 21.0
- 04-18-2013 @ 0521 – 25.0
- 04-18-2013 @ 0608 – 27.0
- 04-18-2013 @ 0655 – 26.0
- 04-18-2013 @ 0827 – 26.0
- 04-18-2013 @ 1051 – 23.0
- 04-18-2013 @ 1431 – 13.3
- 04-18-2013 @ 1655 – 9.4
- 04-18-2013 @ 1850 – 8.0
- 04-18-2013 @ 2112 – 6.3
- 04-18-2013 @ 2255 – 5.5
- 04-19-2013 @ 0134 – 4.4
- 04-19-2013 @ 0502 – 4.1
- 04-19-2013 @ 1203 – 2.6

Case

- When the resident placed a central venous catheter in the victim, he thought he hit an artery since the blood was bright red. An ultrasound confirmed venous placement.
- *The team was perplexed by this discovery*

Why did she die?

post-gazette.COM
Pittsburgh Post-Gazette

Ferrante sentenced to life in cyanide poisoning death of wife Autumn Klein

February 4, 2015 12:32 PM

By Paula Reed Ward / Pittsburgh Post-Gazette

Robert Joseph Ferrante will spend the rest of his life in prison with no chance for parole after he was sentenced this morning on a single count of first-degree murder.

The mandatory penalty for killing his wife, Autumn Klein, in April 2013, was imposed by Common Pleas Judge Jeffrey A. Manning following a short hearing.

"Robert Ferrante, do you wish to make a statement on your sentence?" the judge asked.

Case Example
Silencing the Agitated Patient

- A 30 y/o male found on a porch, agitated, calling out. The patient reportedly was smoking crack, shooting-up amphetamines and drinking Wild Turkey.

- Vital signs at scene by first responders
  - BP 138p HR 120 RR 26
  - RA biox 78%; 98% on 10 liters

2:36 AM
0:00

Physical Examination

- Pt placed on stretcher calling out, complaining of chest pain.

- Pt responds to a few questions, but inconsistent. He follows a few simple commands.

2:46 AM
0:10

Physical Examination

- **BP 94/38 HR 129 RR 45 WARM Biox 88% on 4L**
- **HEENT: Abrasions on forehead, Pupils equal, 6mm**

  Heart: RR, Tachycardic

  Lungs: Scattered crackles; difficulty assessing secondary pt cooperation

  Abd: + Voluntary guarding but no tenderness

  Ext: Bilateral knee abrasions

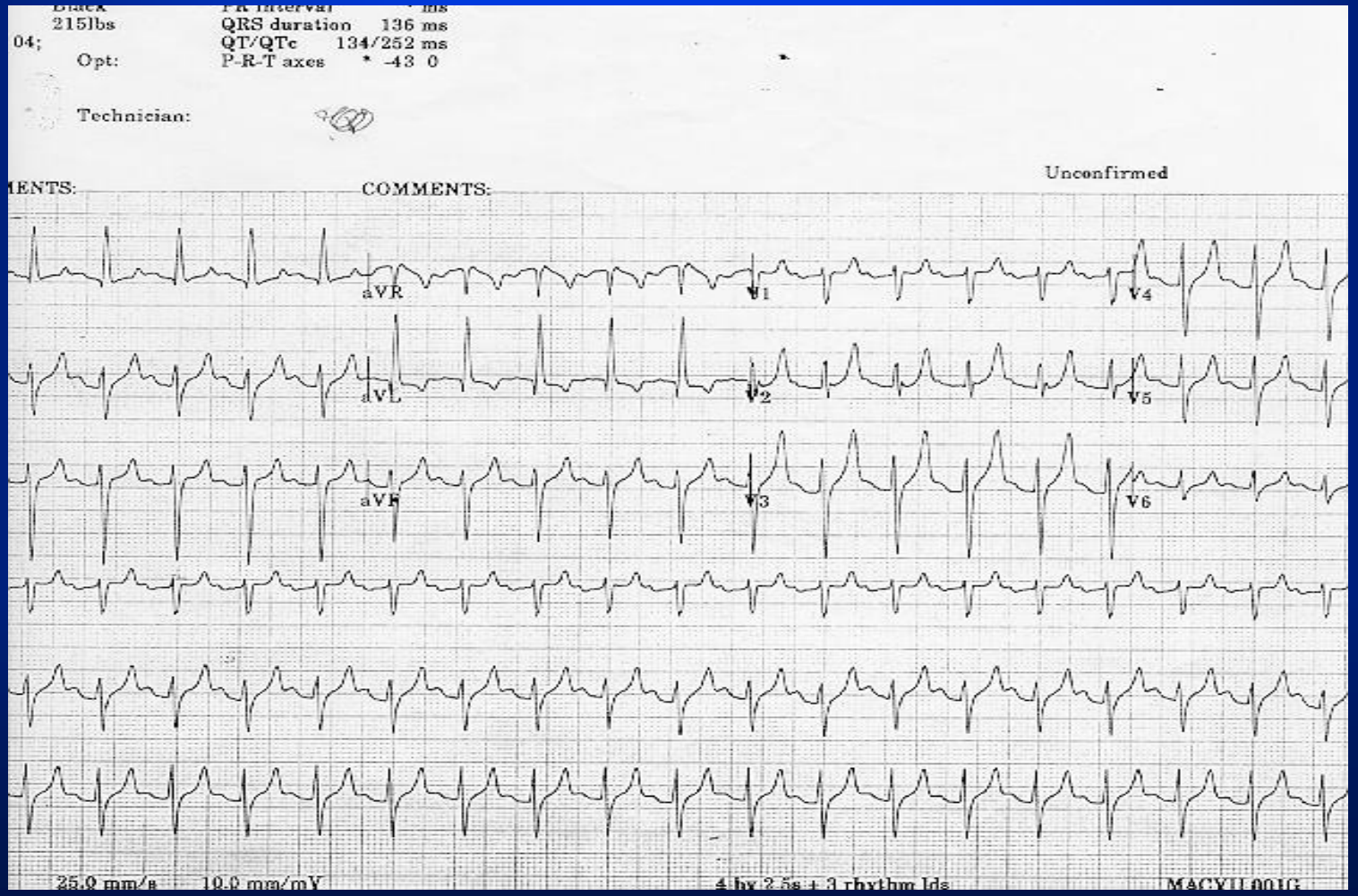
  Neuro: Disoriented to time & place, "acting out," difficult to undress or get BP b/c "resisting"

2:46 AM
0:10

Monitor

2:46 AM
0:10

Case


215lbs
QRS duration 136 ms
QT/QTc 134/252 ms
Opt:
P-R-T axes * -43 0
Technician:
COMMENTS:
Unconfirmed
aVR
V1
V4
aVL
V2
V5
aVF
V3
V6
25.0 mm/s
10.0 mm/mV
MACVU001G

Doctor...

- Pt agitated and not cooperating
- Call made to receiving facility
- Instructed to give 2 mg Versed
- Also lasix IV for presumed pulmonary edema

2:50 AM
0:14

Monitor

What Treatment?

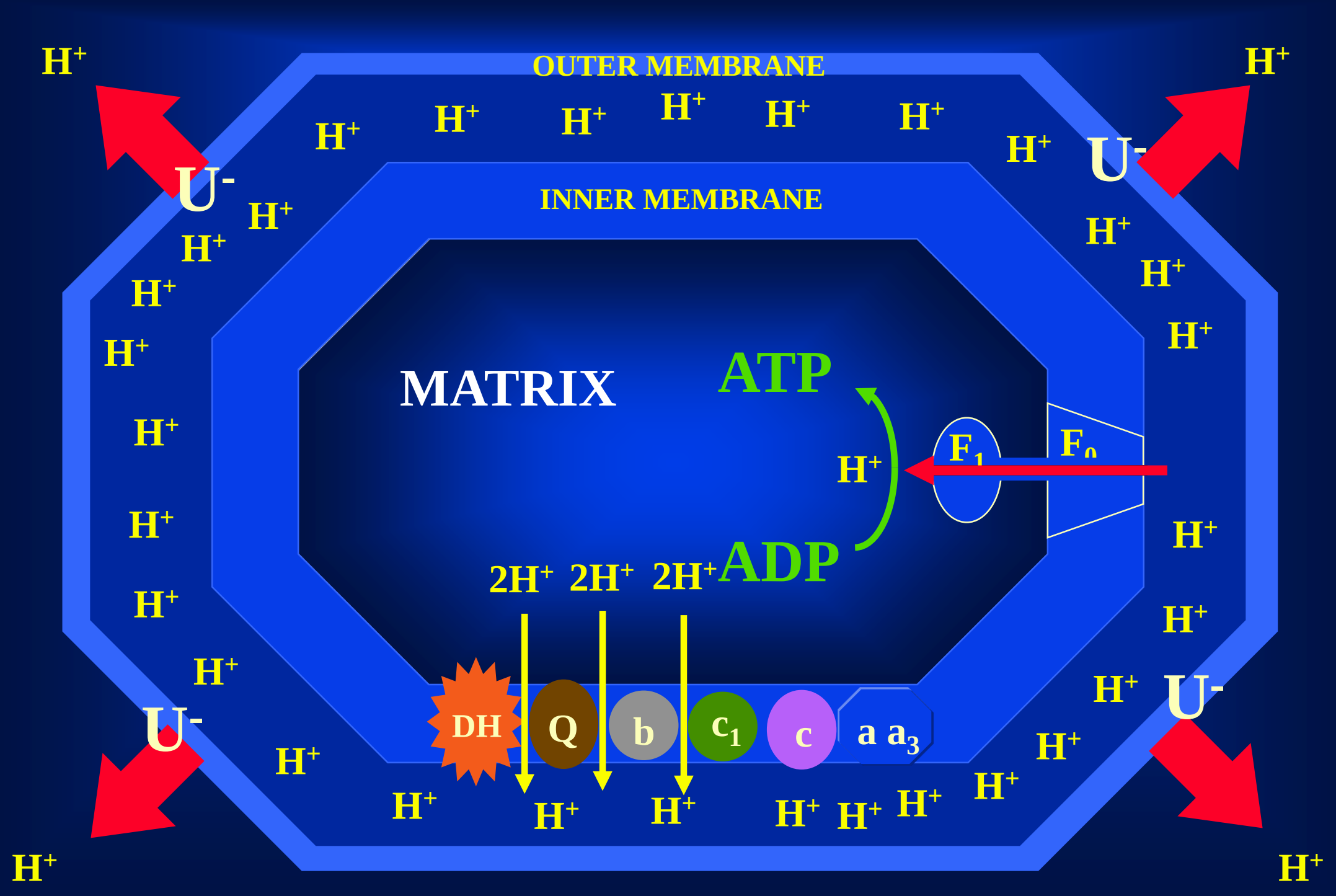
2:56 AM
0:20

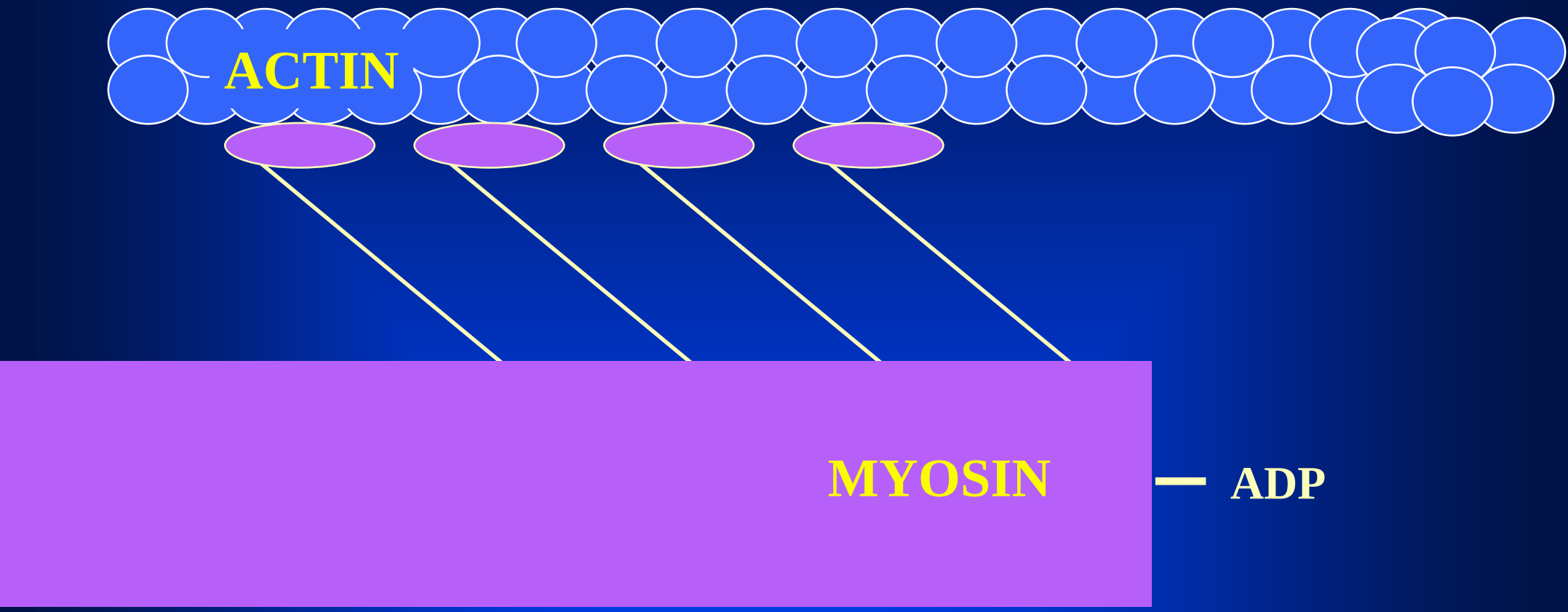
Hyperkalemic...

- 1 amp calcium
- 2 amps bicarbonate
- 1 amp D50

- Complexes begin to widen out
- Intubated
- Arrive to ED
  - I-stat K is 9.5
  - Temp 106.7
  - Stiff as a board

3:00 AM
0:24

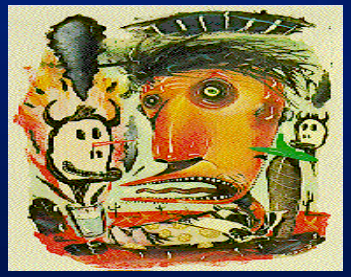

OUTER MEMBRANE
INNER MEMBRANE
MATRIX
ATP
ADP
H+
U-
2H+ 2H+ 2H+
DH
Q
b
c1
c
a a3
F1
Fo



In the Absence of ATP

Treatment

- **Benzodiazepines**
  - decrease neuronal output and preserve ATP
  - Stabilize the mitochondrial membrane and inhibit uncoupling by specific agents
- **Non-depolarizing Paralytics**
  - allows remaining ATP to be preserved soley for vital functions
- **Hyperthermia**
  - Mist with fans
  - Ice packs in axilla/groin
  - IV fluids
  - Avoid rebound (39^{o} C=102.2)
  - No use for acetaminophen, alcohol bath

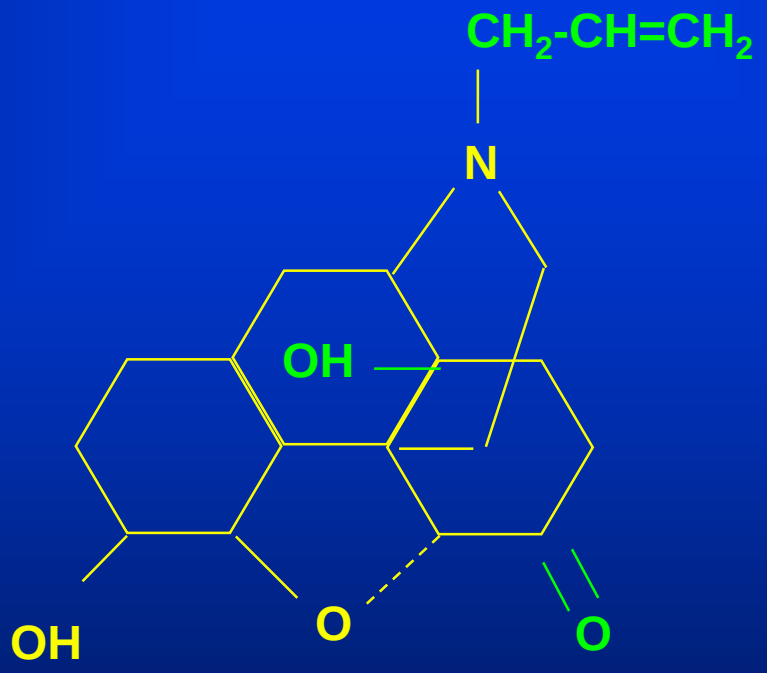


Case Example
Wake her up

- 37 y/o f ingested ? quantity of Flexeril and MS Contin
- Unresponsive
- P 90, RR shallow & 6, BP 90 palp
- pupils are 2mm
- lungs clear
- heart tachycardic
- abdomen soft, no bowel sounds
- monitor: sinus tach, QRS 80 msec

What Treatment?

Wake her up



Naloxone
(Narcan)

Wake her up

- 2 mg Narcan given IV push
- Patient sits upright, becomes wildly agitated
- Kicks paramedic
- Tears IV out of arm

What happened?

Clinical Data

- History
- Scene evaluation
- Activity of those around victim
- Physical examination
  - Vital signs
  - Nystagmus
  - Pupil size
  - Speech pattern
  - Odor to breath
  - Reflexes
  - Clonus
  - Stability (e.g., ataxia, finger to nose)
  - Thought process (e.g., orientation)

Case Example
What Appears Routine…

EMS

- **CC: Abdominal Pain**
- **Call received: 19:38**
- **1st arrive scene: 19:49**
- **Notes: 76 y/o, conscious, breathing OK, kidney pain, fell out of bed twice and still on the floor**
- **POC glucose 82**
- **At hospital 20:16**

Time: 0

Case

EMS

(reported later, not documented)

- She had slurred speech
- She couldn’t walk
- She was unable to sit up on her own and had to be held in that position.
- She did seem confused during the transport.

Time: 0

Case

Emergency Department

- 2020 - Triage: Pt arrives via RS from home. 2 ground level falls while trying to go to BR. Pt has hematoma to the rt ant head. Pt has marked slurred speech which is not her norm. Pt had a CVA in 2007, received TPA. Pt was 182/80 en route. Pt also reports L flank pain. She has passed 1 stone already but as more to pass per husband.
- 2028 – Coumadin, Alcohol & substance use denies
- 2101 – P 89, RR 20, BP 207/110, 98%

Time: 42 min

Case

Emergency Department

ED Physician Notes

- CC: Altered Mental Statue
- 76 y/o, history obtained by husband, progressive confusion over the course of the day. He said it began early in the morning, thinks it may have gotten worse at about 1800.
- She did suffer a couple of falls at home…after rolling out of bed and falling when she tried to get up.
- The primary thing he noted was “sleepiness” and “slurred speech.”
- He did not notice any facial droops or asymmetric weakness.

Time: unknown

Case

Emergency Department

ED Physician Notes

- [The patient] is not really able to give any specific history.
- The husband states she has been complaining of some abdominal and flank pain. She has been diagnosed with kidney stones. No fevers, nausea, vomiting, diarrhea or headache.
- PMH: HTN, DVT, Protein S & C deficiency, CVA s/p TPA, nephrolithiasis, Takotsubo syndrome, colonic inertia, PUD, divert
- PSH: total colectomy with ostomy.
- Meds: coumadin, MVI, oxycodone, ondansetron, diclofenac, lorazepam, lisinopril, carvedilol, furosemide, bupropion, venlafaxine, trazadone

Case

Emergency Department

ED Physician Physical Examination

- General: does not appear to be in any distress
- VS: afeb, P 80s, BP 200/110, 98%
- HEENT: echhymosis over rt forehead and rt supraorbital ridge.
- Neck: neg; Lungs: CTA; Heart: RRR no murmur
- Abd: soft, seems to be nontender w/o masses, osteomy RLQ
- Ext: neg
- Neurologic: sleepy, but arousable and responsive, somewhat dysarthric, no focal findings, seems to have symmetric strength in her upper and lower extremities

Case

Emergency Department

- 2227 – ED dysphagia screening – too lethargic

Time: 1 hr 47 min

Case

Emergency Department

- 2050 – 1st labs:
- Hgb 15.6, Hct 48.4, PLT 334
- INR 2.59, PT 29.3, PTT 47
- Na 139, K 3.6, Cl 105, HCO3 14; Cr 1.06; BUN 15, Glu 90
-
- TBili .02, AlkP 67, AST 19, ALT, 28, CK 203, Ca 9.1

Case

Emergency Department

- CT Head – no acute changes
- pCXR – negative
- Bladder scan – over a liter and catheter inserted
- CT Abd/Pelvis – stone on the lf with some hydronephrosis which had been previously identified but otherwise unremarkable

Case

Emergency Department

- 2101 – RR 20, P 89, GCS 15
- 2226 – RR 24, P 95, GCS 14
- 2227 – dysphagia screening: “too lethargic”
- 2239 – RR 23, P 96, GCS 14
- 2249 – RR 26, P 92, GCS 14
- 2300 – RR 40, P 93, GCS 14
- 0010 – RR 26, P 107, GCS 14
- 0129 – RR 24, P 96, GCS 12
- 0230 – RR 18, P 87, GCS 12

Why worse?

Case

Emergency Department

- 0415 – 6.83/22/210/99%, lactate 7.6
- 0430 – RR 13, P 71
- 0430 – patient intubated
- 0708 – First dose of bicarbonate given
- 0738 – 6.99/22/133/99%; i-calcium 4.2 mg/dL (4.6-5.16)
- 1117 – 6.78/17/154/99%
- 1156 – 2nd chem – HCO3 5; Cr 2.07; Ca 7.1 (8.4-10.7)
- 1319 – sodium thiosulfate

Case

Emergency Department

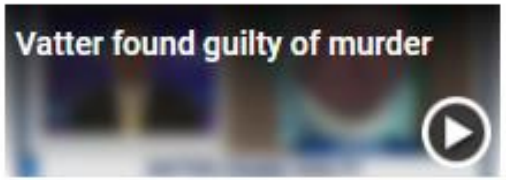
- 0130 – UA – “amorphous crystals”; “occasional” calcium oxalate crystals”

Case

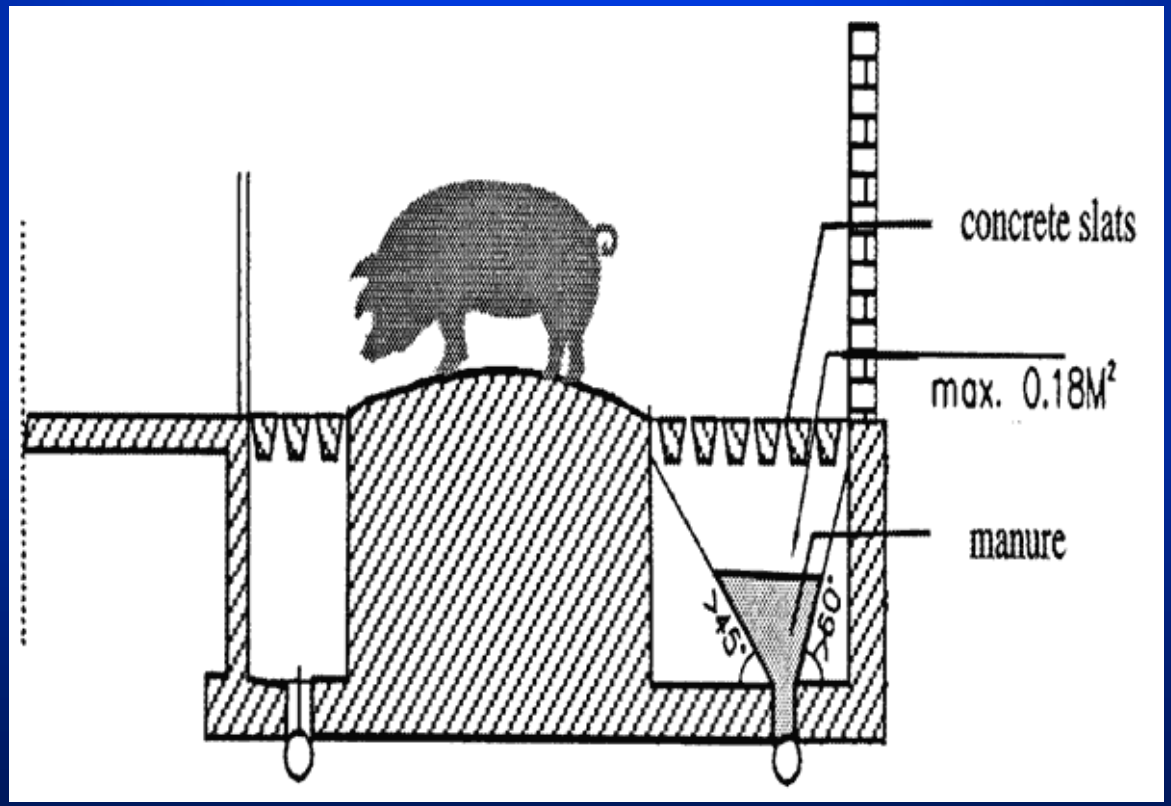
Emergency Department

- 2050 – 1st labs: EG 487 mg/dL
- 1419 – fomepizole ordered
- 1532 – dialysis port placed
- 1600 – dialysis started
- 1613 – 6.76/24/142/98%

Verona man convicted of murder in wife's 2014 poisoning death



Case Example
Don’t Enter the Pit



MMWR 1993;42(17):325-329

Don’t Enter the Pit

- Minnesota: August , 1992
- A 41 y/o farm employee and his 27 y/o nephew attempt to pump out a 12-foot-deep, 49-inch diameter manure pit.
- Pump intake is clogged.
- Attempt to extract the pump from the pit.
- Rope breaks.
- 27 y/o descends a ladder 9 feet into pit to attach new rope.
- He is overcome and falls off the ladder into the pit.
- The uncle summons rescue personnel & the farm owner.
- The owner attempts to physically restrain uncle
- The uncle descends the ladder into the pit 10 min after the nephew; he also is overcome and falls into the pit.

Don’t Enter the Pit

- Twenty minutes after the initial entry, both men were removed from the pit by rescue personnel equipped with appropriate respiratory protection (self-contained breathing apparatus).
- Cardiopulmonary resuscitation was initiated, and the men were transported to a hospital.

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What killed these two men?

Don’t Enter the Pit

Atmospheric readings in the pit on September 2 during the investigation detected no measurable levels of hydrogen sulfide or methane and an oxygen level of 20.4% (normal: 19.5%-21.0%).

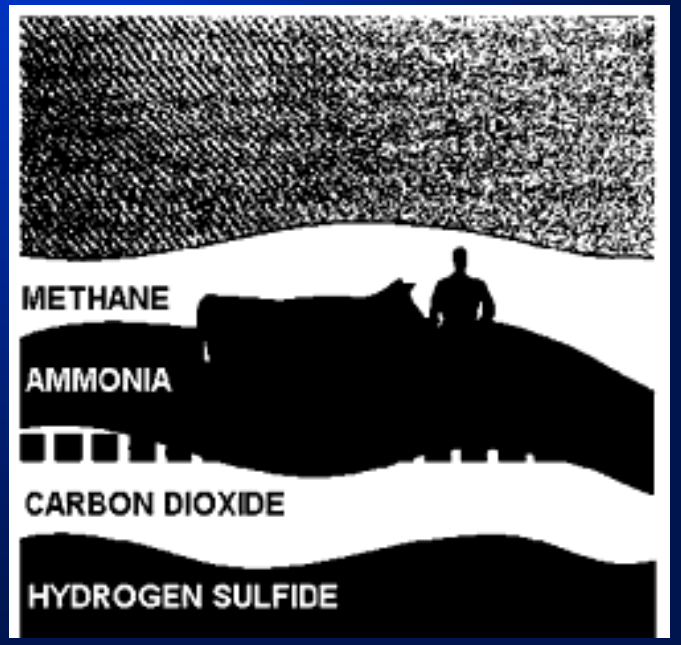
What killed them?

Don’t Enter the Pit

The weather conditions on the day the readings were taken (cool and breezy) differed from those on the day of the incident (hot and humid).

Manure Pit

- Anaerobic bacterial action that decomposes the manure can generate:
  - methane
  - hydrogen sulfide
  - carbon dioxide
  - ammonia
- Death can result from:
  - explosion
  - oxygen deficiency
  - direct effects of the toxic gases



HYDROGEN SULFIDE

- Colorless gas
- Denser than air
- Odor of rotten eggs
- Highly lipid soluble
  - Easy penetration of biological membranes
- Potent inhibitor of cytochrome oxidase
  - Binds ferric (Fe+3) moiety of a_3 complex
- K^+ channel-mediated hyperpolarization neurons

- 0.02 ppm odor threshold
- 20 ppm intense odor
- 50 ppm mucus membrane irritation
- > 100 ppm olfactory fatigue

HYDROGEN SULFIDE
clinical

- Mucus membrane irritation
- Keratoconjunctivitis
- Corneal ulcerations (*gas eye*)
- Rhinitis
- Bronchitis
- Pulmonary edema
- Loss of consciousness (*knockdown*)
- Paralysis of respiratory center of brain
- Delayed neuropsychiatric sequelae
  - Amnestic syndrome, Parkinsons, delerium, dementia
  - Hearing impairment, vision loss, anosmia
- Myocardial depression and infarct

HYDROGEN SULFIDE treatment

- Remove
- Oxygen

ROCKINGHAM COUNTY

Four Family Members, Farmhand Killed by Gas Fumes in Manure Pit

By Bill Brubaker
Washington Post Staff Writer
Wednesday, July 4, 2007

Four members of a Shenandoah Valley dairy farming family and a hired hand died Monday evening after breathing methane gas fumes inside a manure pit, Rockingham County authorities said yesterday.

The deaths occurred in rapid succession, as the hired hand tried to save the farmer, who was overcome with fumes while working inside the pit, which was enclosed and poorly ventilated, authorities said. The farmer's wife and two daughters then jumped into the 10-foot hole, where they also died from exposure to the odorless gas, a byproduct of liquefied manure.

The incident in Briery Branch, about a dozen miles southwest of Harrisonburg, left two young members of the Mennonite farm family orphaned, Capt. J.B. Wittig of the Rockingham sheriff's department said.

"It was just a horrific event," said Wittig, who visited the scene Monday night and again yesterday afternoon. "You have to remember that this is a very tightknit community, and the family members are in shock."

Federal safety officials have been warning farmers about the dangers of entering manure pits for almost two decades.

Yesterday, the Virginia Department of Labor and Industry, which administers federal worker-safety standards in the state, opened an investigation to determine whether any federal work-related regulations were violated.

The National Institute for Occupational Safety and Health warned in a 1990 bulletin that "many farm workers appear to be unaware of the immediate danger posed by entry into manure pits. Like other types of confined spaces, manure pits present special problems regarding worker awareness of hazards."

Yesterday, the occupational safety institute advised farm workers to "never enter a manure pit unless absolutely necessary, and only when proper safeguards have been taken."

Monday's incident unfolded shortly after 6 p.m. when farm owner Scott Showalter, 34, was