Acute Amitriptyline Overdose
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Target Audience: Emergency Medicine Residents, Medical Students

Primary Learning Objectives:

1. Recognize signs and symptoms of tricyclic antidepressant/amitriptyline toxicity
2. Recognize importance of ECG in TCA overdose and ECG findings of sodium channel blockade
3. Describe technique for alkalinizing serum
4. Discuss potential complications of serum alkalinization
5. Order appropriate laboratory and radiology studies in tricyclic antidepressant overdose

Secondary Learning Objectives: detailed technical/behavioral goals, didactic points

1. Perform a mental status evaluation of the altered patient
2. Formulate independent differential diagnosis in setting of leading information from RN
3. Describe how to make a bicarbonate infusion.
4. Describe importance of potassium replacement during serum alkalinization
5. Describe how to manage sodium channel blockade when refractory to alkalinization

Critical actions checklist:

1. Perform endotracheal intubation
2. Obtain peripheral IV access for resuscitation with crystalloid fluid
3. Obtain ECG
4. Obtain appropriate labs
5. Initiate serum alkalinization
6. Sedate with GABA agonist
7. Consult Poison Center/Toxicologist
8. Admit to the MICU

Environment:

1. Room Set Up – ED acute care area
    a. Manikin Set Up – Mid or high fidelity simulator, simulated sweat if available
    b. Props – Standard ED equipment
2. Distractors – ED noise

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CASE SUMMARY

SYNOPSIS OF HISTORY/ Scenario Background

The setting is an urban emergency department.

Patient is a 36-year-old female with a history of anxiety and depression brought to the emergency department by EMS for altered mental status and possible overdose. The patient was last seen well at 2:30 PM. She was found unresponsive at 3:30 PM. There were bottles of trazodone and butalbital-acetaminophen-caffeine nearby, but no pills were missing.

PMHx: depression, anxiety, migraines
PSHx: none
Medications: butalbital-acetaminophen-caffeine, trazodone, amitriptyline, sumatriptan
Allergies: NKDA
SocHx: smokes 1 pack-per-day (cigarettes), social alcohol, no illicit or recreational drugs (per family report)

[Patient has overdosed on amitriptyline; she is stuporous, hypotensive and tachycardic. She is placed in the acute care area of the emergency department.]

SYNOPSIS OF PHYSICAL

Patient is initially stuporous (only grimacing to pain), tachycardic, hypotensive.
Airway is not protected.
Neurologic exam notable for the above mental status. She has profound patellar hyperreflexia and sustained ankle clonus.
Pupils are midrange, briskly reactive.
Skin is dry.
Abdominal exam shows diminished bowel sounds with suprapubic fullness

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CRITICAL ACTIONS

1. **Perform endotracheal intubation**

   Patient requires endotracheal intubation.
   Cueing Guideline: Nurse can note that the patient starts to vomit while being unresponsive and that the airway is not protected.

2. **Obtain peripheral IV access for resuscitation with crystalloid fluid**

   Bilateral large bore peripheral IV access should be established as the patient is hypotensive and tachycardic. 1-2 L of crystalloid should be given.
   Cueing Guideline: The nurse may say, "We have a line in place. Would you like any fluids?" Alternatively, the nurse can mention the tachycardia. If not done the patient will become more tachycardic (140) and BP may drop to 75/43.

3. **Obtain ECG**

   Order and obtain ECG. The participant should note the wide QRS (and prolonged QTc) and sinus tachycardia.
   Cueing Guideline: The nurse can mention that the QRS looks wide on the monitor. If not done, the patient will develop runs of ventricular tachycardia.

4. **Obtain appropriate labs**

   To meet this critical action, the participant must obtain at least a metabolic panel, salicylate level (minimally detectable), acetaminophen level (minimally detectable), ethanol level (undetectable), and TCA screen (positive).
   Cueing Guideline: The nurse can ask if any labs or drug levels should be obtained. If resident/student asks for an amitriptyline level, nurse or lab tech can state only a qualitative screen is available. The use of serum or urine for this is immaterial.

5. **Initiate serum alkalinization**

   Recognition of sodium channel blockade. Two-to-four ampules of sodium bicarbonate should be given as a bolus, and a bicarbonate infusion (**150 mEq of sodium bicarbonate - three ampules - in 1 L of D5W**) should be started.
   Cueing Guideline: Nursing can note continued apparent widening of QRS on monitor. Repeat ECG will show QRS widening to 160 msec. If still not done, the patient will start to become bradycardic and develop ventricular tachycardia. Return of spontaneous circulation (ROSC) will not be achieved using standard ACLS interventions (e.g., epinephrine, defibrillation, compressions) until sodium bicarbonate is given.

6. **Sedate with GABA agonist**

   After intubation, lorazepam, midazolam, or propofol should be used for sedation.
   Cueing Guideline: If not done, patient will become agitated on ventilator. If still not done, patient will seize and will continue to seize until a GABA agonist is given in appropriate dosing.

7. Consult Poison Center/Toxicologist

The local poison center or Toxicology Service should be consulted for further management recommendations (pH goals, pressor choices, etc.)
Cueing Guideline: Nurse can ask if the doctor has called the Poison Center/Toxicologist yet.

8. Admit to the MICU

Admit to the MICU for definitive care. Patient will not be stable for any other destination (e.g. telemetry or floor unit). Any attempt to admit elsewhere will be blocked by accepting physician.
Cueing Guideline: The nurse can ask the doctor if anyone has called the intensivist to arrange for a definitive disposition decision.

Critical Actions Checklist[1]

Resident Name	
Case Description	

Skills measured **Core competencies: PC** Patient care, **MK** Medical knowledge, **IC** Interpersonal and communication skills **P** Professionalism, **PB** Practice-based learning and improvement **SB** Systems-based practice	Very Unacceptable		Unacceptable		Acceptable		Very Acceptable	
Data Acquisition (D) PC MK I	1	2	3	4	5	6	7	8
Problem Solving (S) PC MK PB	1	2	3	4	5	6	7	8
Patient Management (M) PC MK IC P PB SB	1	2	3	4	5	6	7	8
Resource Utilization (R) PC PB SB	1	2	3	4	5	6	7	8
Health Care Provided (H) PC SB	1	2	3	4	5	6	7	8
Interpersonal Relations (I) IC P	1	2	3	4	5	6	7	8
Comprehension of Pathophysiology (P) MK PB	1	2	3	4	5	6	7	8
Clinical Competence (C) PC MK IC P PB SB	1	2	3	4	5	6	7	8

Critical Actions

Yes	No		Comments:
		Perform endotracheal intubation	
		Obtain peripheral IV access for resuscitation with crystalloid fluid	
		Obtain ECG	
		Obtain appropriate labs	
		Initiate serum alkalinization	
		Sedate with GABA agonist	
		Consult Poison Center/Toxicologist	
		Admit to the MICU	

Yes	No	
		Dangerous actions

[1] Modified ABEM Oral Certification Examination checklist and scoresheet

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HISTORY

You are called to see a new patient (36-year-old female) in the Acute Care area of the emergency department. You see a female who appears sleepy lying on a gurney.

Onset of Symptoms: Today

Background Info: 36-year-old female is stuporous and difficult to arouse. She cannot provide history. She was last known well around 2:30 PM and found in this state around 3:30 PM. Her boyfriend couldn't arouse her so he called 911. It is now 4:30 PM.

Additional History

From EMS: If asked about the scene in the apartment they will describe a cluttered, small apartment. Near the patient were bottles of trazodone and butalbital-acetaminophen-caffeine, with pills still in them. There was vomitus at the scene.

From Boyfriend: He states that he and the patient had had an argument that morning. She has never tried to hurt herself. She had been complaining of a headache that morning.

Chief Complaint: Altered mental status

Past Medical Hx: Depression, anxiety, migraine

Past Surgical Hx: None

Habits:
Smoking: 1 ppd
ETOH: social
Drugs: none

Family Med Hx: Hypertension, diabetes

Social Hx:

Marital Status:	Single, in committed relationship
Children:	None
Education:	High School
Employment:	Receptionist

ROS: Patient is unable to answer.

CASE CONTINUATION

The patient is swiftly brought to the treatment area. Initial vital signs are obtained.

Vital Signs: BP: 92/60 mmHg P: 134/minute R: 22/minute T: 37C (98.6F) POx: 94% (FiO_2=0.21)

Primary Survey

Airway – Compromised, patient does not appear to protect airway
Breathing – Mild tachypnea, 94% SpO_2
Circulation – Tachycardia (130's), SBP 90's, radial pulses diminished
Disability – Patient is stuporous. She only grimaces to pain.
Exposure – No trauma, rash, drug patches.

Required Actions within the First Two Minutes

- Establish safety net (IV, oxygen, cardiac monitor, two large bore IVs, draw blood for labs)
- A/B – Provide supplemental oxygen and prepare to intubate patient. Intubate patient.
- C – Cardiac monitor; 2L NS IV bolus for presumed volume depletion; ECG – recognize wide QRS (144 msec)
- D – Point-of-care glucose = 97 mg/dL; labs are sent

Branch Points

- **IF NO INTERVENTION OCCURS,** then the patient's blood pressure drops to 80/45 mmHg, and the tachycardia increases to 140s/minute.

PHYSICAL EXAM

General Appearance: Young female. Unresponsive.

Updated Vital Signs: BP: 90/54 mmHg P: 130/minute R: 36/minute T: 37C (98.6F) POx: 90% (FiO_2=0.21)

Head: Normocephalic and atraumatic; facial diaphoresis

Eyes: PERRLA, pupils 4-5 mm bilaterally

Ears: TM's normal.

Mouth: Dry mucous membranes, intubated (if performed by this time)

Neck: Trachea midline, supple

Skin: Dry axillae, no rashes, warm

Chest: Mild tachypnea. No trauma. Good chest rise

Lungs: Clear, equal bilaterally, non-labored, if the patient has been intubated, mechanical breath sounds

Heart: Tachycardic, S1 S2, no murmurs

Back: Normal

Abdomen: Soft, non-tender, no signs of trauma, no rebound/guarding, decreased bowel sounds, fullness in suprapubic area

Extremities: No signs of trauma, no edema, radial pulses weak, central pulses strong

Genital: Digital vaginal exam negative for retained foreign body

Rectal: Normal tone, guaiac negative

Neurological: Grimaces to pain, 4+ patellar reflexes with sustained ankle clonus (if not sedated and paralyzed for endotracheal intubation by this time), upper extremity reflexes normal

Mental Status: Stuporous

Required Actions within the Next Two Minutes

- Further resuscitation with an additional IV NS 1-2 L
- Administer 2-4 50-mL ampules of 8.4% $NaHCO_3$ IV bolus
- Portable CXR for endotracheal tube placement
- May order non-contrast head CT but cannot obtain until patient is more stable
- May place a Foley catheter (drain 900 mL of urine)
- Initiate sedation with GABA agonist

Branch Points

- **DESPITE INTERVENTIONS,** systolic blood pressure will remain in the 90's mmHg.

Required Actions within the Next Two Minutes

- ED diagnostics should be available by this time
- Aspirin, acetaminophen, and ethanol levels should be provided
- A TCA screen, if it had been ordered, should be provided by this time

Branch Points

- **IF ADDITIONAL IV CRYSTALLOID FLUID BOLUSES ARE NOT PROVIDED,** then the systolic blood pressure will drop to the 60s mmHg, and the tachycardia will increase to the 150s/minute.
- **IF SODIUM BICARBONATE IS NOT ADMINISTERED,** then the QRS on the monitor will widen, and the systolic blood pressure will drop to 55-60 mmHg.

Required Actions within the Next Two Minutes

- Check venous pH: goal for serum alkalinization is 7.50-7.55
- Administer an additional 2-4 50-mL ampules of 8.4% $NaHCO_3$ IV bolus
- Mix/order a $NaHCO_3$ drip (3 ampules of 8.4% $NaHCO_3$ – **150 mEq $NaHCO_3$ in 1L D_5W**) and run at 250mL/hr

Branch Points

- **IF SODIUM BICARBONATE IS NOT ADMINISTERED,** then the patient's heart rate begins to drop and hypotension worsens. **IF A REPEAT ECG IS OBTAINED AT THIS POINT,** the QRS has widened to 160 milliseconds.
- **IF SODIUM BICARBONATE CONTINUES TO BE WITHHELD,** then the patient develops refractory ventricular tachycardia (VT) and dies, unless bicarbonate given during resuscitation
- **IF SODIUM BICARBONATE IS GIVEN,** blood pressure appears to respond, although patient remains hypotensive with systolic blood pressures in the 90s-100s and MAPs in the 55-60 range

Required Actions within the Next Two Minutes

- Norepinephrine or phenylephrine may be chosen as a vasopressor and started at this time
- Call the Poison Center or Consultation with the Toxicologist should be performed at this time

Branch Points

- **IF SERIAL POTASSIUM AND PH ARE NOT ORDERED AND CHECKED,** then the patient's QRS widens and the patient develops VT and dies.

Required Actions at the End of the Case

- Additional central venous access as required
- Lidocaine may also be used if VT develops
- Replete potassium, consider adding to bicarbonate infusion
- Call MICU for admission and definitive disposition

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STIMULUS INVENTORY

#1	Complete blood count
#2	A: Initial Basic metabolic panel
	B: Repeat Basic metabolic panel
#3	Urinalysis
#4	Liver function tests
#5	Venous blood gas
#6	Cardiac enzymes
#7	Toxicology
#8	Radiology (CXR, CT head)
#9	Repeat Venous Blood Gas
#10	ECG
#11	Repeat ECG (verbal report)

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LAB DATA & IMAGING RESULTS

Stimulus #1	
Complete Blood Count (CBC)	
WBC	17,400/mm^3
Hemoglobin	14.2 g/dL
Hematocrit	44%
Platelets	279,000/mm^3
Differential	
PMNLs	45%
Lymphocytes	55%
Monocytes	2%
Eosinophils	1%

Stimulus #2A and #2B		
Initial / Repeat BMP		
Sodium	139 mEq/L	147 mEq/L
Potassium	4.1 mEq/L	2.9 mEq/L
Chloride	106 mEq/L	111 mEq/L
Bicarbonate	16 mEq/L	19 mEq/L
Glucose	92 mg/dL	95 mg/dL
BUN	18 mg/dL	12 mg/dL
Creatinine	1.1 mg/dL	1 mg/dL

Stimulus #3	
Urinalysis	
Color	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Trace
Leuk. Esterase	Negative
Nitrites	Negative
WBC	3/hpf
RBC	2/hpf

Stimulus #4	
Liver Function Tests	
AST	37 U/L
ALT	28 U/L
T. Bilirubin	1.1 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL
Protein	7 mg/dL

Stimulus #5	
Venous Blood Gas	
pH	7.39
pCO_2	38 mm Hg
pO_2	52 mm Hg
HCO_3	17 mEq/L base deficit 6
O_2 saturation	70%

Stimulus #6	
Cardiac Enzymes	
Troponin	< 0.01 ng/mL

Stimulus #7	
Toxicology	
Salicylate	Undetectable
Acetaminophen	15 mcg/mL
Ethanol	Undetectable
Urine drug screen	
Amphetamines	Negative
Benzodiazepines	Negative
Cocaine	Negative
Opiates	Negative
TCAs	Negative
THC	Negative

Stimulus #8	
Radiology	
CXR	Normal
CT head	Normal

Stimulus #9	
Repeat VBG	
pH	7.43
pCO_2	37
pO_2	70
HCO_3	20 mEq/L base deficit 6
O_2 saturation	68%

Stimulus #10
ECG: Sinus tachycardia, QRS 144, QTc 550, No pathologic ST elevation, RBBB morphology

Stimulus #11 (verbal report)
Repeat ECG: Sinus tachycardia, QRS 160, QTc 570, No pathologic ST elevation, RBBB morphology

Stimulus #1

Complete Blood Count (CBC)

WBC	17,400/mm^3
Hemoglobin	14.2 g/dL
Hematocrit	44%
Platelets	279,000/mm^3
Differential	
PMNLs	45%
Lymphocytes	55%
Monocytes	2%
Eosinophils	1%

Stimulus #2A

Initial BMP

Sodium	139 mEq/L
Potassium	4.1 mEq/L
Chloride	106 mEq/L
Bicarbonate	16 mEq/L
Glucose	92 mg/dL
BUN	18 mg/dL
Creatinine	1.1 mg/dL

Stimulus #2B

Repeat BMP

Sodium	147 mEq/L
Potassium	2.9 mEq/L
Chloride	19 mEq/L
Bicarbonate	111 mEq/L
Glucose	95 mg/dL
BUN	12 mg/dL
Creatinine	1 mg/dL

Stimulus #3

Urinalysis

Color	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Trace
Leuk. Esterase	Negative
Nitrites	Negative
WBC	3/hpf
RBC	2/hpf

Stimulus #4

Liver Function Tests

AST	37 U/L
ALT	28 U/L
T. Bilirubin	1.1 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL
Protein	7 mg/dL

Stimulus #5

Venous Blood Gas

pH	7.39
pCO_2	38 mm Hg
pO_2	52 mm Hg
HCO_3	17 mEq/L base deficit 6
O_2 saturation	70%

Stimulus #6

Cardiac Enzymes

Troponin	< 0.01 ng/mL

Stimulus #7

Toxicology

Salicylate	Undetectable
Acetaminophen	15 mcg/mL
Ethanol	Undetectable
Urine drug screen	
Amphetamines	Negative
Benzodiazepines	Negative
Cocaine	Negative
Opiates	Negative
TCAs	Negative
THC	Negative

Stimulus #8

Radiology

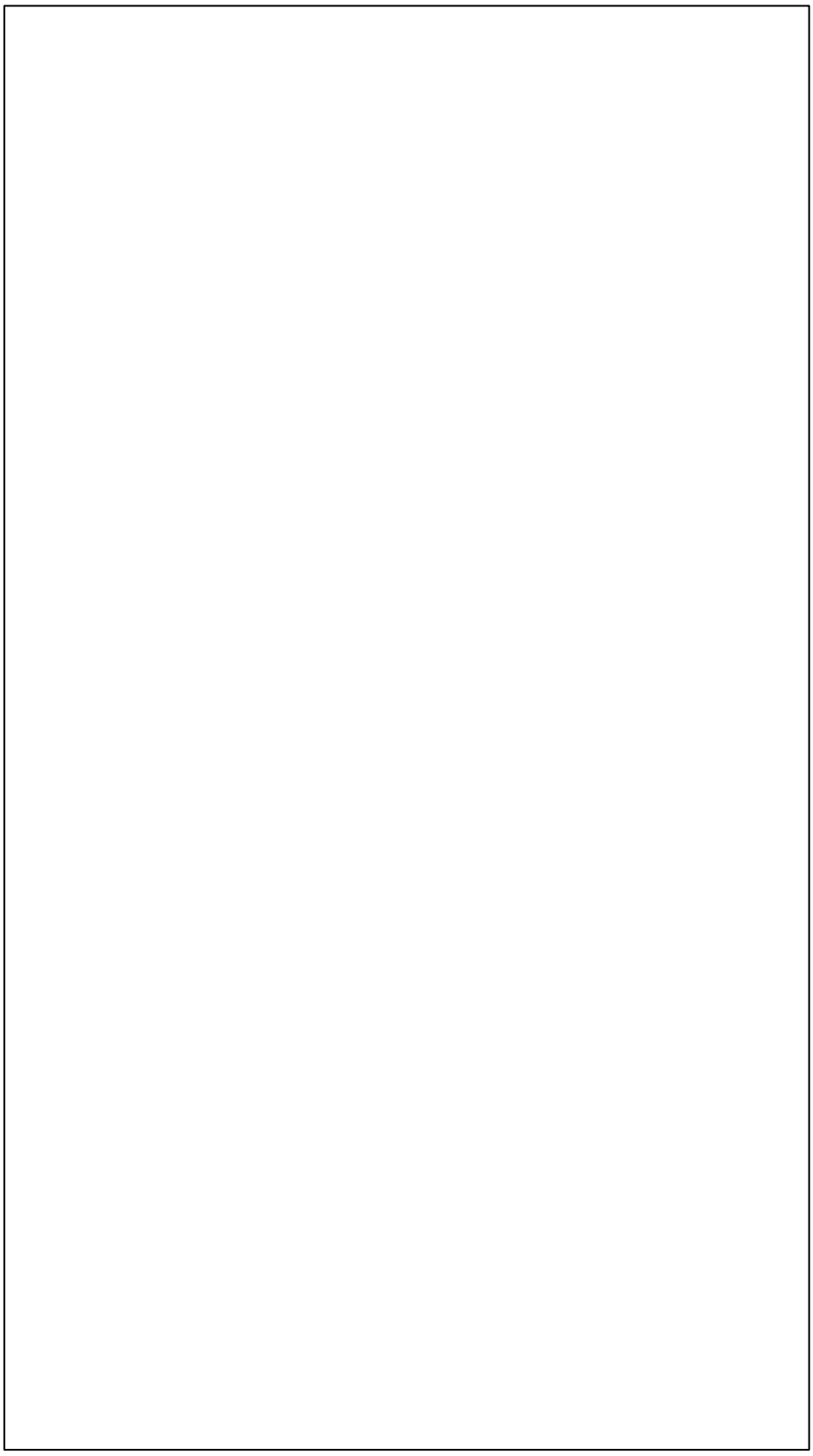
CXR	Normal
CT head	Normal

Stimulus #9

Repeat VBG

pH	7.43
pCO_2	37
pO_2	70
HCO_3	20 mEq/L base deficit 6
O_2 saturation	68%

Stimulus #10



Debriefing Materials – <u>Tricyclic Antidepressant Toxicity</u>

Sources of Exposure:

- Examples of TCAs: protriptyline, amitriptyline, nortriptyline, imipramine, clomipramine, desipramine, doxepin
- No longer first-line for depression, but still used
- Finding new uses in other disease processes: sleep (amitriptyline, doxepin), headache (amitriptyline, nortriptyline), neuropathic pain, irritable bowel syndrome
- In pediatrics, used for ADHD, enuresis

Pathophysiology:

- 7 mechanisms of TCA toxicity:
    - Muscarinic receptor antagonism
    - Biogenic amine reuptake inhibition (therapeutic mechanism)
    - Histamine (H1) receptor antagonism
    - Alpha-adrenergic receptor antagonism
    - GABA receptor antagonism
    - Cardiac sodium channel antagonism
    - Cardiac potassium channel antagonism

Severity of Ingestion:

- In acute overdose, fatal cardiac dysrhythmias are rare with VT/VF developing in 4%
- Children younger than 6 account for 12-13% of exposures, a strongly disproportionate number compared to demographics of population prescribed TCAs
- 1-2 adult-strength tablets are sufficient to produce severe symptoms or death in young children
- Seizures occur in 4% of acute overdoses and in 13% of those that result in death
- Death directly due to TCA toxicity usually occurs within hours of overdose, delayed deaths due to complications of toxicity such as ARDS, septic shock, trauma after seizures, etc.

Organ System Effects:

- Psychiatric:
    - Antimuscarinic effects may cause agitated delirium. Early, this may manifest as hallucinations, disorientation, and combativeness. Antimuscarinic toxicity will generally persist after resolution of cardiotoxicity.
- Pulmonary:
    - Aspiration pneumonitis and ARDS may occur secondary to loss of airway protective reflexes, delirium, and seizures.
- Cardiovascular:
    - Acute lethality after TCA overdoses frequently due to cardiovascular toxicity
    - Hypotension develops from several mechanisms:
        - Alpha-adrenergic blockade resulting in inappropriate vasodilation
        - Cardiac Na channel blockade resulting in bradycardia and poor inotropy
        - Systemic effects including volume depletion, metabolic acidosis, and hypoxemia
    - Sinus tachycardia is the most common dysrhythmia.
        - Reflex tachycardia in setting of alpha-adrenergic blockade

        - Muscarinic receptor antagonism
        - Biogenic amine (norepinephrine/dopamine/serotonin) reuptake inhibition
    - ECG characteristically shows intraventricular conduction delay and rightward shift of the terminal 40 ms of the QRS axis (manifested as a prominent terminal R-wave in aVR)
    - ECG findings can be used as a dosimeter of toxicity (see below)
    - Wide-complex tachycardia is the prototypical life-threatening dysrhythmia
    - Prolongation of the QT interval both secondary to and independent of QRS prolongation may occur
- Neurologic:
    - TCAs uniformly cause central nervous system toxicity in life-threatening overdose
    - CNS toxicity may range from agitated delirium to sedation to seizures
    - Doxepin is profoundly sedating due to potent antihistamine effects and may cause coma with minimal cardiovascular effects
    - Delirium, agitation, and/or psychosis result from muscarinic receptor antagonism
    - Seizures are generally brief and occur early in toxicity; status epilepticus is unusual
    - Serotonergic symptoms are also common and can be differentiated from antimuscarinic/sympathomimetic effects by recognition of lower extremity hyperreflexia and clonus out of proportion to upper extremity reflexes
    - Mild CNS toxicity may manifest as blurred vision, dizziness, or ataxia
- Other:
    - Multisystem organ toxicity and failure secondary to hypotension, shock, hypoxemia
    - Antimuscarinic findings may include any of: mydriasis, dry mucous membranes, urinary retention, decreased GI motility and ileus, dry/flushed skin

Diagnostic Testing:

- Quantitative serum TCA levels are not practical
- Qualitative serum or urine TCA is a widely available test
    - Many false positives: 1st generation antihistamines, atypical antipsychotics, carbamazepine, cyclobenzaprine, etc.
- Chemistry panel
    - Repeat as needed
    - Keep potassium within normal range
- Blood gas
    - Serial venous blood gases every 2 hours to ensure accurate pH titration
- Electrocardiogram
    - QRS duration can be used as dosimeter
        - QRS >100 ms portends increased seizure risk, consideration of prophylactic lorazepam depending on mental status
        - QRS >140 ms portends increased risk of ventricular dysrhythmia and warrants aggressive management
    - QT prolongation may occur
    - If treating with bicarbonate, repeat every 2 hours to ensure QRS is narrowing or stable
    - Repeat ECG if mental status worsening

Treatment:

- Decontamination
    - Oral activated charcoal can be considered only in patients presenting less than 1 hour after ingestion and with normal mental status
    - No role for lavage or whole bowel irrigation
- Administer lactated Ringer or isotonic sodium chloride solution for volume expansion with goals of correcting hypotension and maintaining 1-1.5-mL/kg/h urine output.
- Physostigmine: theoretically contraindicated owing to risk of unmasking cardiac potassium channel blockade effects by slowing heart rate and decreasing seizure threshold in setting of GABA-antagonistic effects of TCAs
- Vasopressors: titrate to improving markers of perfusion: mean arterial pressure, capillary refill, lactate, urine output
    - Norepinephrine 1st line: start at 0.1 mcg/kg/min
    - Epinephrine 2nd line: start at 0.1 mcg/kg/min
    - Phenylephrine 3rd line (unless tachycardia profound, may use as 1st line): start at 0.5-1 mcg/min
    - Vasopressin 4th line: 0.4 units/min
    - AVOID dopamine – TCA inhibits reuptake of dopamine, thus, conversion to norepinephrine is blocked
- If QRS >100 ms consider 1-2 mg of lorazepam for seizure prevention if mental status can tolerate
- If QRS >100-120 ms, initiate serum alkalinization (see below)
- Alkalinization of serum disrupts TCA binding to cardiac sodium channels due to slight conformational change
    - 1-2 mEq/kg sodium bicarbonate boluses repeated until QRS narrowing or pH at goal
    - Start infusion of D5W + 150 mEq NaHCO3 + 40 mEq KCl at 1.5-2.5 cc/kg/hr
    - Titrate bicarbonate infusion to pH 7.5-7.55
    - Maintain serum potassium in normal range
- Hypernatremia: if QRS continues to widen or ventricular dysrhythmia develops despite goal pH, induce hypernatremia with goal sodium 150-155 mEq/L
    - Bolus 100 cc 3% sodium chloride until goal sodium met
- Lidocaine: if ventricular tachycardia/fibrillation refractory to pH and sodium optimization, use lidocaine for rhythm control. Amiodarone, may prolong QT interval further.
    - Bolus lidocaine 1-1.5 mg/kg (or 100 mg to keep simple)
    - Initiate lidocaine infusion at 2-4 mg/min
- Elimination: there is no benefit for HD nor MDAC
- Heroic measures: consider intravenous lipid emulsion or extracorporeal membrane oxygenation (ECMO) for refractory shock

Consultations:

- Consult the regional poison center or a local medical toxicologist for additional information and patient care recommendations.

Disposition:

- All potential ingestions require 6 hours of observation to ensure delayed toxicity does not develop
- Admit patients with major signs and symptoms to an ICU.

- Consult psychiatric service personnel for stabilized patients with intentional overdose.

Take-Home Points:

- Obtain ECG early in toxicity
- ECG can be used as a dosimeter.
- 7 mechanisms of toxicity:
    - Sodium channel blockade: wide QRS, cardiogenic shock, dysrhythmias
    - Potassium channel blockade: prolonged QT, dysrhythmias
    - Antihistamine: sedation
    - Antimuscarinic: anticholinergic syndrome
    - Alpha-adrenergic blocker: vasoplegic shock, reflex tachycardia
    - GABA antagonist: seizures
    - Biogenic amine reuptake inhibition: sympathomimetic, seizures, hallucinations, serotonin syndrome, dopamine unresponsiveness
- 6-hours observation for suspected ingestions due to risk of delayed toxicity
- Treatment principles include stabilizing the ABCs, fluid resuscitation, sodium bicarbonate in the setting of sodium channel blockade, GABA agonists for seizures or agitation
- Physostigmine theoretically contraindicated
- If QRS >120 ms, alkalinize serum to pH 7.5-7.55. If ventricular dysrhythmia develops despite alkalinization, push sodium to 150-155 with hypertonic saline.
- Lidocaine is antidysrhythmic of choice if dysrhythmia refractory to alkalinization and hypernatremia
- Replace potassium to maintain the potassium-hydrogen exchange in the renal tubules and to maintain alkalinization.
- Assess serial ECGs every 1-2 hours, along with venous pH and electrolytes in severe, acute toxicity

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