

Target Audience: Emergency Medicine Residents, Medical Students

Primary Learning Objectives:

1. Recognize signs and symptoms of aspirin (ASA)/salicylate toxicity
2. Perform appropriate gastric decontamination/enhanced elimination
3. Describe technique for alkalinizing urine
4. Discuss potential complications of mechanical ventilation
5. Recognize indications for hemodialysis in ASA overdose
6. Order appropriate laboratory and radiology studies in ASA overdose

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

1. Obtain psychiatric evaluation for suicidal patients
2. Develop independent differential diagnosis in setting of leading information from RN
3. Describe importance of potassium replacement during urinary alkalization
4. Describe role of repeated ASA levels
5. Describe role of WBI and MDAC in gastric decontamination of ASA ingestion

Critical actions checklist:

1. Perform gastric decontamination with AC – (May consider multi-dose activated charcoal. WBI is optional.)
2. Order ASA level and basic metabolic panel; (then serial ASA levels, potassium, bicarbonate, creatinine)
3. Volume resuscitate with NS
4. Alkalinize urine and replace potassium
5. Consult Poison Center and Nephrology to arrange for dialysis
6. Consider potential problems with mechanical ventilation

Environment:

1. Room Set Up – ED non-critical care area
 - a. Manikin Set Up – Mid or high fidelity simulator, simulated sweat
 - b. Props – Standard ED equipment
2. Distractors – ED noise, ED nurse #2 who insists this patient needs to “sleep it off”

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CASE SUMMARY

SYNOPSIS OF HISTORY/ Scenario Background

The setting is an urban emergency department.

Patient is a 40-year-old female with a history of anxiety, ADHD, and polysubstance abuse brought to the emergency department by EMS for altered mental status, agitation, and rapid respirations. The patient's father said she is always anxious, has recently been depressed, but is not aware of any suicidal ideations.

PMHx: anxiety, ADHD, and polysubstance abuse

PSHx: cholecystectomy

Medications: Alprazolam, Bupropion, Adderall, Sertraline

Allergies: NKDA

SocHx: Binge EtOH use; tobacco, marijuana, prescription opioids; lives alone in own apartment

[Patient has an aspirin overdose, is agitated, and is intoxicated with alcohol. Given her psychiatric history, emotional outbursts, and evidence of alcohol, she is triaged to the behavioral health evaluation area.]

SYNOPSIS OF PHYSICAL

Patient is initially anxious, tachycardic, tachypneic.

Airway is intact.

Neurologic exam is non focal. She is agitated. Mental status is altered – moaning/ cursing, and she appears intoxicated and anxious.

Skin is diaphoretic.

She has vomit on chest.

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CRITICAL ACTIONS

1. Perform GI Decontamination

Perform gastric decontamination with activated charcoal (Lavage or whole bowel irrigation are optional and may help in severe overdose)

Cueing Guideline: The nurse asks if the doctor would like to place an NG tube.

2. Order Appropriate Labs

Order salicylate level, acetaminophen level, and chemistry panel.

Cueing Guideline: The nurse asks if the doctor would like any labs or any levels on the patient.

3. Initiate Volume Resuscitation

Give 1 to 2 liters of NS for volume resuscitation.

Cueing Guideline: The nurse says, "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 90/53.

4. Alkalinize Urine

Alkalinize urine and replace potassium.

Cueing Guideline: Patient will have worsening acidosis and hypokalemia (see second chemistry panel) if not treated. If the patient is not treated, she will become more altered, acidotic, apneic, seize, and die. Even if the patient is treated the ASA will continue to increase, and the patient will need dialysis.

5. Consult Poison Center (PC)

Consult PC

Cueing Guideline: The nurse asks if the PC has been called yet **or** if the doctor wants the PC called. The nurse may also ask if there is anything more that can be done to eliminate ASA since the patient is so symptomatic (e.g. elevated ASA level, acidosis, and altered mental status).

6. Arrange for Dialysis

Arrange for dialysis.

Cueing Guideline: The nurse asks if the PC has been called yet **or** if the doctor wants the PC called. The nurse may also ask if there is anything more that can be done to eliminate ASA since the patient is so symptomatic (e.g. elevated ASA level, acidosis, and altered mental status).

7. Exercise caution with intubation

Consider potential problems.

Critical Actions Checklist¹

Resident Name								
Case Description								
Skills measured <small>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</small>	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 GI decontamination						
		Order appropriate labs						
		Initiate volume resuscitation						
		Alkalinize urine						
		Consult poison center						
		Arrange for dialysis			Yes	No		
		Exercise caution with intubation			<input type="checkbox"/>	<input type="checkbox"/>	Dangerous actions	

¹ Modified ABEM Oral Certification Examination checklist and scoresheet

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HISTORY

You are called to see a new patient (40-year-old female) in the Psychiatric Treatment area of the emergency department. You see a pale, diaphoretic female who is altered.

Onset of Symptoms: Today

Background Info: 40-year-old female is anxious, depressed, agitated, with labile emotions, and not answering questions clearly. The patient's father said he found her earlier today confused and breathing rapidly. She didn't improve, so he called 911.

Additional History

From EMS: If asked about the scene in the apartment they will describe a cluttered, small apartment. There were a few empty beer cans and a large empty bottle of aspirin. She vomited during transport.

From Father: He states that the patient has been anxious and depressed. She recently broke up with her boyfriend and has been under stress.

Chief Complaint: Anxiety

Past Medical Hx: Anxiety, ADHD, and polysubstance abuse

Past Surgical Hx: Cholecystectomy

Habits: Smoking: Occasional
ETOH: Binge drinking
Drugs: Marijuana, prescription opioids

Family Med Hx: Hypertension, diabetes

Social Hx: Marital Status: Single
Children: None
Education: High School
Employment: Unemployed

ROS: Patient is unable to answer.

CASE CONTINUATION

Shortly after patient is triaged into the ED behavioral unit, the nurse requests a chemical sedation order for the patient's agitation.

Vital Signs: BP: 94/58 mmHg P: 130/minute R: 38/minute T: 38C (100.4F) POx: 90%

Primary Survey

Airway – Patent

Breathing – Tachypnea and hyperpnea, 100% POx

Circulation – Tachycardia (130's), SBP 110's

Disability – Patient is agitated, anxious. Has difficulty hearing and focusing on questions but answers appropriately with short phrases of 2-3 words between labored breaths. Airway is intact with preserved gag and cough reflex.

Exposure – No trauma, rash, drug patches. Patient is diaphoretic

Required Actions

- First move the patient to a higher acuity treatment area.
- Establish safety net (IV, oxygen, cardiac monitor, two large bore IVs, draw blood for labs)
- A/B – Oxygen
- C – cardiac monitor; 2L NS IV bolus for presumed volume depletion; ECG
- D – Finger stick glucose = 130mg/dL; labs are sent

Branch Point

- **IF NO INTERVENTION OCCURS**, BP drops to 90/50, patient becomes unresponsive, and seizes.
- **AFTER MOVING THE PATIENT TO A HIGHER ACUITY TREATMENT AREA OF THE ED**, you notice that the patient becomes nonverbal and only withdraws to painful stimuli.

PHYSICAL EXAM

General Appearance: Pale, diaphoretic female. Unresponsive.

Vital Signs: **BP: 90/54 mmHg P: 130/minute R: 36/minute T: 38C (100.4F) Pox: 90%**

Head: Normal

Eyes: PERRLA, pupils 2 mm B

Ears: TM's normal. Decreased hearing

Mouth: Smells of alcohol, no trauma, dry mucous membranes and lips

Neck: No tenderness or deformity on exam, full range of motion

Skin: Moist skin/sweaty, no rashes, warm

Chest: Increased respiratory rate without any signs of distress (no retractions)

Lungs: Clear, equal bilaterally with rapid, deep breaths but labored

Heart: Tachycardic, S1 S2, no murmurs

Back: Normal

Abdomen: Soft, nontender, no signs of trauma, no rebound/guarding, decreased bowel sounds

Extremities: No signs of trauma, no edema, pulses are present

Genital: Digital vaginal exam negative for retained foreign body

Rectal: Normal tone, guaiac negative

Neurological: Non-focal exam, no clonus

Mental Status: Unable to assess due to AMS

Required Actions

- Further resuscitation with IV NS 1-2 L
- May order portable CXR and KUB (signs of pulmonary edema, gastric concretions, or other acute pathology)
- May order non-contrast head CT but cannot obtain until patient is more stable
- May place a Foley catheter (drain 300 mL of urine)

CASE CONTINUATION

- SBP remains in 90s
- Initial ASA level is 86 mg/dL

Branch Point

- **IF ANOTHER 1-2L NS NOT GIVEN ABOVE**, BP drops to 60's, and patient seizes.

Required Actions

- Administer 2-3 50-mL ampules of 8.4% NaHCO₃ IV bolus
- Mix/order a NaHCO₃ drip (3 ampules of 8.4% NaHCO₃ in 1L D₅W) and run at 250mL/hr
- Add 20-40 mEq/L KCl to NaHCO₃ infusion
 - Pt remains symptomatic during bicarbonate infusion.
- Pt continues to be altered, acidotic, tachypneic. Discussion of impending respiratory failure and managing the airway
- **While preparing for RSI, the ASA level returns = 138 mg/dL**
- VBG at that time shows **pH 7.39, pCO₂ 20 mm Hg, paO₂ 39 mm Hg, base deficit 11**
- Postpone intubation until acidosis is corrected somewhat

Branch Point

- **IF TEAM PROCEEDS WITH INTUBATION WITHOUT CORRECTING ACIDOSIS** (administering bicarb bolus 1-2 amps), they will successfully place the endotracheal tube, but the patient will subsequently seize and die

Required Actions

- Intubate the patient using RSI. Maximize minute ventilation (e.g., TV 500, RR 30, PEEP 5)
- Call the Poison Center
- Consult Medical Toxicology
- Order/obtain serial ASA levels, BMP (for K, HCO₃, cre) every 1-2 hours initially

Branch Point

- **IF SERIAL LEVELS ARE NOT CHECKED**, patient seizes and dies.

Required Actions

- - Consult nephrology for dialysis

Branch Point

- - **IF DIALYSIS NOT PERFORMED**, patient seizes and dies.

Required Actions

- - Additional central venous access and norepinephrine drip as required
 - Call MICU for admission

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STIMULUS INVENTORY

- #1 CBC
- #2 BMP/LFTs
- #3 U/A
- #4 VBG
- #5 Cardiac Enzymes
- #6 Toxicology Labs
- #7 CXR
- #8 CT Head
- #9 Abdominal XR
- #10 Repeat Toxicology Labs
- #11 Repeat BMP
- #12 ECG
- #13 Debriefing materials

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LAB DATA & IMAGING RESULTS

Stimulus #1	
Complete Blood Count (CBC)	
WBC	14,500/mm ³
Hemoglobin	13.2 g/dL
Hematocrit	40%
Platelets	239,000/mm ³
Differential	
PMNLs	45%
Lymphocytes	55%
Monocytes	2%
Eosinophils	1%
Bands	1%

Stimulus #2	
Basic Metabolic Profile (BMP)	
Sodium	145 mEq/L
Potassium	3.6 mEq/L
Chloride	109 mEq/L
Bicarbonate	16 mEq/L
Glucose	73 mg/dL
BUN	17 mg/dL
Creatinine	1.1 mg/dL

Stimulus #3	
Liver Function Tests	
AST	49 U/L
ALT	32 U/L
Alk Phos	110 U/L
Total Bilirubin	1.2 mg/dL
Direct Bilirubin	0.2 mg/dL
Albumin	4 mg/dL
Protein	7 mg/dL

Stimulus #4	
Urinalysis	
Color	Yellow
Specific gravity	1.017
Glucose	Negative
Protein	Negative
Ketones	Trace
Leuk. esterase	Negative
Nitrite	Negative
WBC	3/hpf
RBC	2/hpf

Stimulus #4	
Arterial Blood Gas	
pH	7.44
pCO ₂	20 mm Hg
pO ₂	101 mm Hg
HCO ₃	14 mEq/L
SaO ₂	94% (FiO ₂ =0.21)

Stimulus #5	
Cardiac enzymes	
Troponin	0.025 ng/mL

Stimulus #6	
Toxicology	
Salicylate	85 mg/dL
Acetaminophen	Undetectable
Ethanol	112 mg/dL

Stimulus #7	
CXR: normal	

Stimulus #8	
Head CT: normal	

Stimulus #9	
AXR: normal	

Stimulus #10	
Repeat toxicology	
Salicylate	141 mg/dL

Stimulus #11	
Repeat Basic Metabolic Panel	
Sodium	146 mEq/L
Potassium	3.2 mEq/L
Chloride	111 mEq/L
Bicarbonate	12 mEq/L
Glucose	68 mg/dL
BUN	12 mg/dL
Creatinine	1.0 mg/dL

Stimulus #12	
ECG	
Sinus tachycardia. No T-wave or ST-segment elevation; no RV strain	

Stimulus #1**Complete Blood Count (CBC)**

WBC	14,500/mm ³
Hemoglobin	13.2 g/dL
Hematocrit	40%
Platelets	239,000/mm ³

Differential

PMNLs	45%
Lymphocytes	55%
Monocytes	2%
Eosinophils	1%
Bands	1%

Stimulus #2**Basic Metabolic Profile (BMP)**

Sodium	145 mEq/L
Potassium	3.6 mEq/L
Chloride	109 mEq/L
Bicarbonate	16 mEq/L
Glucose	73 mg/dL
BUN	17 mg/dL
Creatinine	1.1 mg/dL

Stimulus #3**Liver Function Tests**

AST	49 U/L
ALT	32 U/L
Alk Phos	110 U/L
Total Bilirubin	1.2 mg/dL
Direct Bilirubin	0.2 mg/dL
Albumin	4 mg/dL
Protein	7 mg/dL

Stimulus #4**Urinalysis**

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

Stimulus #5

Cardiac enzymes

Troponin	0.025 ng/mL
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Stimulus #6**Toxicology**

Salicylate	85 mg/dL
Acetaminophen	Undetectable
Ethanol	112 mg/dL

Stimulus #7

Stimulus #8

Stimulus #9

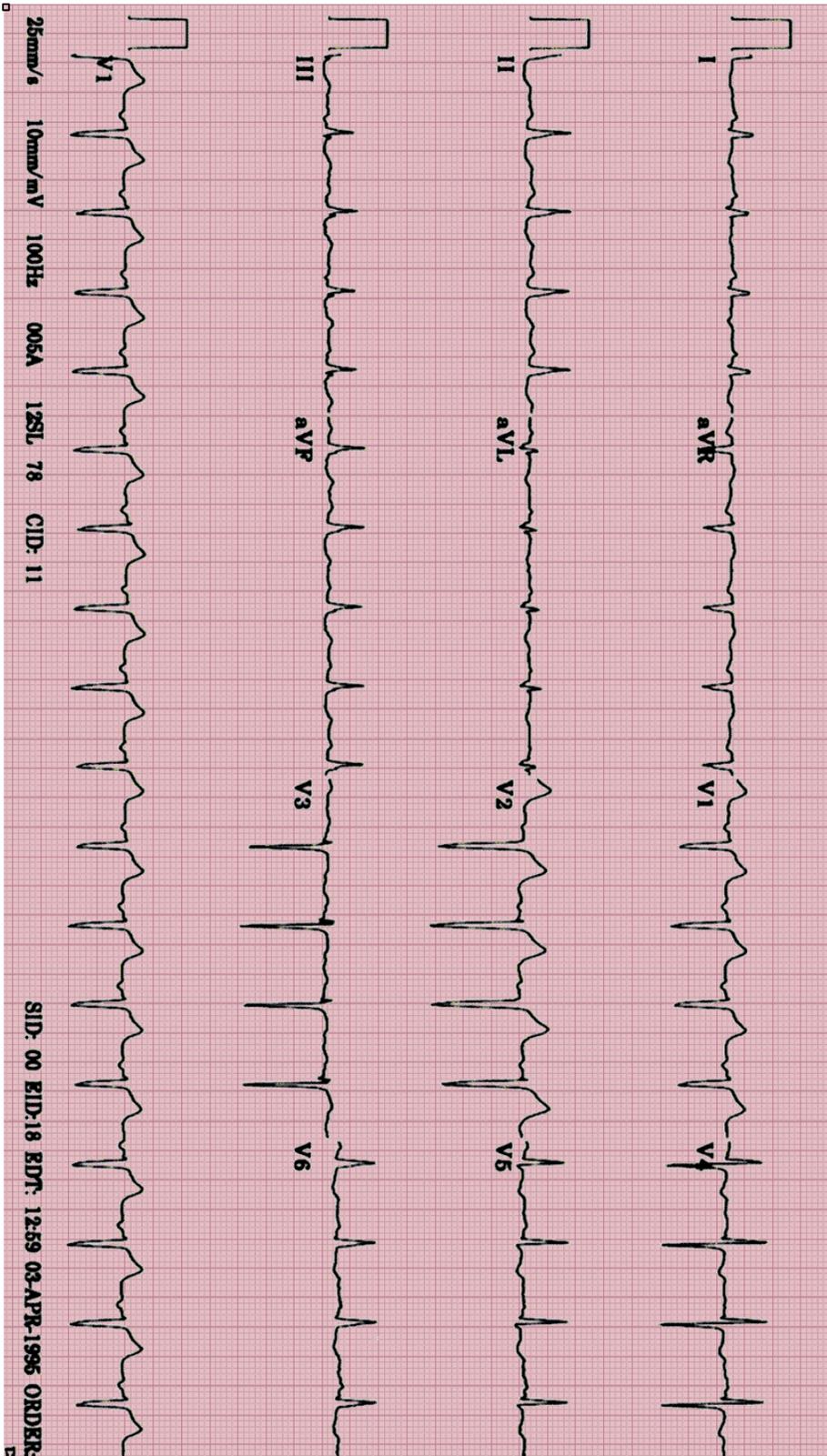
Stimulus #10

Repeat toxicology

Salicylate	141 mg/dL
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Stimulus #11**Repeat Basic Metabolic Panel**

Sodium	146 mEq/L
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Bicarbonate	12 mEq/L
Glucose	68 mg/dL
BUN	12 mg/dL
Creatinine	1.0 mg/dL



Debriefing Materials - Salicylate Toxicity

Sources of Exposure:

- Salicylates are found in hundreds of over-the-counter medications and in numerous prescription drugs
- Pepto-Bismol, a common antidiarrheal agent, contains 131 mg of salicylate per tablespoon
- Aspirin or aspirin-equivalent preparations include children's aspirin (80-mg tablets), adult aspirin (325-mg tablets)
- Methyl salicylate (e.g., oil of wintergreen) - One teaspoon of 98% methyl salicylate contains 7000 mg of salicylate - more than 4 times the potentially toxic dose for a child who weighs 10 kg

Pathophysiology:

- Salicylates uncouple oxidative phosphorylation intracellularly limit production of ATP, and increase lactate production, leading to ketosis and a wide anion-gap metabolic acidosis
- Salicylates stimulate the respiratory center, leading to hyperventilation and respiratory alkalosis

Severity of Ingestion:

- In acute overdose, morbidity rate is 16%, and mortality is 1%
- Prognosis is worse for chronic overdose/exposure because they are often missed
- The following 4 categories are helpful for assessing the potential severity and morbidity of an acute, single event, nonenteric-coated, salicylate ingestion:
 - Less than 150 mg/kg - Spectrum ranges from no toxicity to mild toxicity
 - 150-300 mg/kg - Mild-to-moderate toxicity
 - 301-500 mg/kg - Serious toxicity
 - Greater than 500 mg/kg - Potentially lethal toxicity

Organ System Effects:

- Psychiatric:
 - The chronic ingestion of salicylates may produce the appearance of anxiety with its associated tachypnea, difficulty concentrating, and hallucinations. Patients with underlying psychiatric illness may present with symptoms suggestive of an exacerbation of their underlying psychiatric illness (e.g., mania, psychosis)
- Pulmonary:
 - Salicylates cause both direct and indirect stimulation of respiration. A salicylate level of 35 mg/dL or higher causes increases in both rate (tachypnea) and depth (hyperpnea) of respiration. Salicylate poisoning may rarely cause noncardiogenic pulmonary edema (NCPE) and acute lung injury in pediatric patients.
- Cardiovascular:
 - Tachycardia, Hypotension
- Neurologic:
 - Salicylates are neurotoxic; this initially manifests as tinnitus. CNS toxicity is related to the amount of drug bound to CNS tissue. It is more common with chronic than acute toxicity. Acidosis worsens CNS toxicity by increasing the amount of salicylate that crosses the blood brain barrier and increases CNS

tissue levels. Other signs and symptoms of CNS toxicity include nausea, vomiting, hyperpnea, and lethargy. Severe toxicity can progress to disorientation, seizures, cerebral edema, hyperthermia, coma, cardiorespiratory depression, and, eventually, death.

- The final common pathway is seizure, coma, death
- Gastrointestinal:
 - Nausea and vomiting are the most common toxic effects. This can be caused by CNS toxicity or by direct damage to the gastric mucosa.
- Dermatologic:
 - Diaphoresis is a common sign in patients with salicylate toxicity.

Diagnostic Testing:

- Chemistry panel
 - Repeat as needed
- Serum salicylate level
 - Every 2 hours until the salicylate level falls to less than 30 mg/dL
 - Do NOT use the Done nomogram
 - Serum levels determined less than 6 hours postingestion (acute overdose) do not rule out impending toxicity because salicylates are in the absorption-distribution phase
 - In cases of chronic salicylism, measured toxic levels may be only 30-40 mg/dL
 - Acute overdoses are often symptomatic at salicylate concentrations higher than 40-50 mg/dL
 - Patients with salicylate concentrations approaching or exceeding 100 mg/dL usually have serious or life-threatening toxicity
- Urinalysis: Monitor and maintain an alkaline urine pH every 2 hours during alkalinization therapy. Maintain a urine pH of 7.5-8.
- Monitor glucose levels closely. Initial hyperglycemia may give way to hypoglycemia.
- Obtain hepatic, hematologic, and coagulation profiles for patients with clinical evidence of moderate-to-severe toxicity
- Chest x-ray is indicated if evidence of severe intoxication, pulmonary edema, or hypoxemia is present
- Consider an abdominal x-ray if an aspirin concretion is suspected

Treatment:

- Decontamination
 - Gastric lavage may be beneficial in severe, large volume overdose
 - Oral activated charcoal, especially if the patient presents within one hour of ingestion.
 - Repeated doses of charcoal may enhance salicylate elimination and may shorten the serum half-life. Most experts strongly recommend this for patients with a serious ingestion.
 - When enteric-coated aspirin has been ingested or when salicylate levels do not decrease despite treatment with charcoal, WBI should be used in addition to charcoal therapy.
- Administer lactated Ringer or isotonic sodium chloride solution for volume expansion at 10-20 cc/kg/hr until a 1-1.5-cc/kg/h urine flow is established.

- Alkalinization of urine creates a gradient that attracts the unionized salicylate from the brain tissue into the blood stream and then into the urine. The goal is to keep salicylates away from brain tissue, move them to the urine, “trap” them in the urine in an ionized state, and then excrete them.
 - When the urine pH increases from 5 to 8, salicylate renal clearance increases 10-20 times.
 - Consider this treatment if the salicylate level is higher than 35 mg/dL.
 - Give a single IV bolus of NaHCO₃ at 1-2 mEq/kg.
 - Mix 3 ampules of NaHCO₃ in 1L of D5W. Add 20-40 mEq KCl.
 - Administer a constant infusion at 1.5-2.5 mL/kg/hr to produce a urine flow of 0.5-1 mL/kg/hr. Closely monitor the serum electrolytes (K), cre, HCO₃, and urine pH. Maintain the urinary pH between 7.5-8.
 - The urinary excretion of salicylic acid is dependent upon adequate serum potassium due to a H⁺/K⁺ exchange. (An alkaline urine traps the salicylate in an unionized state so it cannot be reabsorbed. In the presence of hypokalemia, however, the body will reabsorb K⁺ and secrete H⁺. An acidic urine provides H⁺ to produce unionized salicylate, which can be absorbed.)

Consultations:

- Consult the regional poison center or a local medical toxicologist for additional information and patient care recommendations.
- Consult Nephrology if hemodialysis is indicated.
 - Dialysis is recommended for patients with severe salicylate poisoning who are altered, have respiratory distress, cannot handle a fluid load, severe acidemia (<7.2), or not responding to current therapy. The Extracorporeal Treatments in Poisoning (EXTRIP) Workgroup recommended extracorporeal treatment for high salicylate concentrations regardless of signs and symptoms (>100 mg/dL) or lower thresholds for renal impairment (>90 mg/dL).

Disposition:

- Admit patients with major signs and symptoms to an ICU.
- Consult psychiatric service personnel for stabilized patients with intentional overdose.
- Patients with accidental ingestions of less than 150 mg/kg and no signs of toxicity can be discharged after 6 hours post ingestion.

Take-Home Points:

- Salicylates may have an enigmatic presentation for the unsuspecting clinician.
- Salicylates uncouple oxidative phosphorylation intracellularly – a key point in understanding the pathophysiology of salicylism.
- Salicylates directly stimulate the medullary respiratory center of the brainstem resulting in tachypnea, classically causing an early pure respiratory alkalosis (centrally mediated), followed by an increased anion gap metabolic acidosis with continued hyperventilation.
- Salicylate-intoxicated patients have rapid respiratory rates and large tidal volumes (increased minute ventilations) that are difficult to maintain with a ventilator. If not maintained, acidemia worsens, and death may ensue.
- Treatment principles include stabilizing the ABCs, limiting absorption, enhancing elimination, correcting electrolyte/metabolic abnormalities, and providing supportive care.

- Salicylate toxicity is one indication for multiple doses of charcoal (1 gm/kg) every 4-6 hours administered until salicylate levels are consistently decreasing. (First dose may be given with sorbitol.) WBI may help if not improving.
- Alkalinize the urine early to trap the salicylate molecule in the ionized form in the urine and facilitate excretion by giving intravenous sodium bicarbonate boluses and a bicarbonate infusion at twice maintenance rate.
- Replace potassium to maintain the potassium-hydrogen exchange in the renal tubules and to maintain urinary alkalinization.
- Assess serial salicylate levels every 1-2 hours, along with serum glucose, potassium, bicarbonate, and creatinine levels until the salicylate levels are less than 30 mg/dL.
- Hemodialysis is effective for salicylate removal and may be required continuously to remove tissue stores.

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