

**Target Audience:** Emergency Medicine Residents (junior and senior level postgraduate learners), Medical Students

**Primary Learning Objectives:**

1. Recognize inhalational injury and potential need for early airway management.
2. Recognize potential for cyanide toxicity with concomitant carbon monoxide exposure in fire victim and order cyanide level and co-oximetry for carboxyhemoglobin level.
3. Demonstrate an appropriate treatment protocol for a patient with suspected combined poisoning from cyanide and carbon monoxide using sodium thiosulfate and/or hydroxocobalamin.

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

1. Appropriately uses available resources (poison center)
2. Communicates clearly and effectively while resuscitating a sick patient

**Critical actions checklist:**

1. Obtain peripheral IV access
2. Place on cardiac monitor
3. Order serum carboxyhemoglobin level and basic metabolic panel
4. Provide high-flow supplemental oxygen
5. Order head CT
6. Administer hydroxocobalamin (+/- sodium thiosulfate)
7. Consult Poison Center/Toxicologist
8. Admit to the MICU for definitive care

**Environment:** Emergency Department treatment area

1. Room Set Up – ED critical care area
  - a. Manikin Set Up – Mid or high fidelity simulator
  - b. Props – Standard ED equipment
2. Distractors – ED noise, alarming monitor

**For Examiner Only**

**CASE SUMMARY**

**SYNOPSIS OF HISTORY/ Scenario Background**

**Chief Complaint:** Found unconscious; complaining earlier of syncope and headache

This is a case of a 50-year-old male found unresponsive in burning house. EMS found the patient unresponsive, hypotensive, and tachycardic with soot around the mouth/nares. Resident must intubate the patient, suspect cyanide toxicity, and treat with hydroxocobalamin, in addition to supportive care.

The paramedic who presents with the patient will describe the scene and should provide the participants with information sufficient to increase their suspicion of exposure to toxic inhalants.

If participant recognition of cyanide toxicity is not obvious following the first few minutes of the case (after successful initial airway management and fluids for hypotension/tachycardia), the confederate staff member acting as the nurse or medical technician will note the smell of bitter almonds on the patient's clothes. Alternatively, EMS personnel may return to check on patient status, and remark that acrylic curtains were ablaze, and fire fighters had to use respirators to enter home due to dense acrid smoke.

If a burn specialist is consulted prior to stabilization, they recommend treatment for cyanide toxicity.

If clinical pharmacist is contacted, dosing for standard cyanide kit and hydroxocobalamin are provided.

If patient is not treated with hydroxocobalamin, he deteriorates (becomes more hypotensive and hypoxic despite endotracheal intubation), and dies.

Consultant readily accepts patient in transfer.

**PMHx:** Unknown

**PSHx:** Unknown

**Medications:** Unknown

**Allergies:** Unknown

**SH:** Unknown

**FH:** Unknown

## CASE PLAY

Paramedic's "radio report" to ED medical control:

- **"We are arriving with a critically ill patient. We have an unconscious 50-year-old-appearing man who is tachycardic and hypotensive following his rescue from a house fire. He is the lone victim. He is demonstrating spontaneous respirations. We are giving supplemental oxygen by non-rebreather mask and have an IV in place. We are pulling into the ambulance bay right now."**

The paramedic who brings the patient in reports the neighbors called EMS to report a fire. They also report that when they found the patient, he was unconscious, unresponsive, and unarousable, laying supine on the living room sofa.

### Required Actions within the First Two Minutes

- Establish safety net (IV, oxygen, cardiac monitor, second large bore IV, draw blood for labs)
- A/B – Provide high-flow supplemental oxygen, prepare for emergent endotracheal intubation
- C – Cardiac monitor; NS IV bolus; ECG
- D – Point-of-care glucose = 162 mg/dL; may consider thiamine or naloxone

## CASE CONTINUATION - PHYSICAL EXAM

**General Appearance:** Unresponsive, moderate work of breathing

**Vital Signs:** **BP: 80/48 mmHg P: 130/minute R: 33/minute T: 37.2C (98.9F) POx: 88% (FiO<sub>2</sub>=1, using a non-rebreather mask)**

**HEENT:** Soot around the mouth and nares. No stridor.

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

**Skin:** Soot and smoke-associated debris over face and other areas not covered with clothes. No obvious burned areas. **AT FACULTY DISCRETION, SIGNIFICANT BURNS (SECOND- AND THIRD-DEGREE, LOCALIZED TO SPECIFIC AREAS OR MORE DIFFUSELY DISTRIBUTED) COULD BE ADDED TO THE CASE AS AN ADDITIONAL INJURY SUSTAINED FOR MORE ADVANCED LEARNERS.**

**Chest/CVS:** Tachycardia. Normal heart sounds, no murmurs.

**Lungs:** Breath sounds symmetrically equal. Diffuse bilateral wheezes (from smoke inhalation).

**Back:** Normal

**Abdomen:** Soft, non-tender, and non-distended. No rigidity.

**Extremities:** Normal

**Neurologic:** Decreased level of consciousness. Lethargic, obtunded and confused. Rouses to touch, but markedly confused (groaning and garbled words only).

### Required Actions within the Next Two Minutes

- Patient should be intubated by this time
- Laboratory studies (especially point-of-care glucose, carboxyhemoglobin, lactate, and ABG) should be ordered and sent by this time
- An ECG should be obtained by this time
- Empiric administration of dextrose or other reversal agents (e.g., naloxone) could be considered at this time if laboratory studies are not sent
- Point-of-care radiographic studies may be considered at this time, but patient will not be stable to leave the ED at this point in the case

### Branch Points

- **IF PATIENT RECEIVES EMPIRIC NALOXONE, DEXTROSE, AND/OR THIAMINE**, there will be no change in the patient's status.
- **IF ENDOTRACHEAL INTUBATION IS NOT STARTED WITHIN THE FIRST TWO MINUTES OF THE CASE TO SECURE THE PATIENT'S AIRWAY, THEN THE PATIENT'S AIRWAY WILL BECOME "CRITICAL." THE PATIENT WILL REQUIRE CRICOTHYROIDOTOMY FROM THIS POINT FORWARD.**

### Required Actions within the Next Several Minutes

- Labs return, notable for marked lactic acidosis (despite endotracheal intubation) and "lower-than-expected" elevated carboxyhemoglobin level
- Cyanide toxicity should be suspected at this time
- Consultation with the Poison Center/Toxicologist – **OR** – Hyperbaric specialist – **OR** – Burn Center specialist – **OR** – Clinical Pharmacist should be obtained by this time

## Branch Points

- **IF PATIENT RECEIVES EMPIRIC HYDROXOCOBALAMIN**, there will be **IMPROVEMENT** in the patient's status.
  - **Vital signs: BP: 94/60 mmHg P: 110/minute R: ventilator rate POx: 99%**
- **IF HYDROXOCOBALAMIN (PREFERRED) OR SODIUM THIOSULFATE IS NOT ADMINISTERED**, then the patient progressively deteriorates (hypotension and hypoxia worsen) and dies.
- **IF PARTICIPANTS CONTACT HYPERBARIC SPECIALIST**, the specialist refused to accept the patient with a carboxyhemoglobin level of 10% to the hyperbaric facility, and suggests the participants search for alternative causes for the patient's signs and symptoms.
- **IF PARTICIPANTS CONTACT THE MICU**, then the intensivist will request and recommend consultation with the Poison Center/Toxicologist +/- regional burn center specialist prior to accepting the patient for admission.
- **IF A BURN CENTER SPECIALIST IS CONSULTED**, they recommend treatment for cyanide toxicity and agree to accept the patient once he is more stable.
- **IF CLINICAL PHARMACIST – OR – THE POISON CENTER/TOXICOLOGIST IS CONSULTED**, then the empiric dosing for sodium thiosulfate and hydroxocobalamin are provided (amyl nitrite and sodium nitrite administration are discouraged by the clinical pharmacist).

## Required Actions Toward the End of the Case

- Hydroxocobalamin (or equivalent intervention) should have been administered by this time
- Consultation with the Poison Center/Toxicologist – **OR** – Hyperbaric specialist – **OR** – Burn Center specialist – **OR** – Clinical Pharmacist should have been obtained by this time
- Patient should be more stable (if critical actions have been met) for transfer to the Burn Center

## For Examiner Only

### CRITICAL ACTIONS

#### 1. Identify metabolic acidosis

Identify metabolic acidosis. To meet this critical action, participants should order an ABG, BMP, and/or a serum lactate.

Cueing Guideline: Nurse can ask if the doctor wants any blood tests when the patient arrives.

#### 2. Place on cardiac monitor

Place on cardiac monitor

Cueing Guideline: Nurse can ask if the doctor wants the patient placed on a cardiac monitor and other adjuncts.

#### 3. Order serum carboxyhemoglobin and point-of-care serum glucose

Order serum carboxyhemoglobin level and point-of-care serum glucose. Participants should consider these diagnostic tests in the context of a patient found unconscious and unresponsive inside a house that is on fire.

Cueing Guideline: The nurse asks if the doctor wants any specific diagnostic tests for a patient presenting from a house fire with acute mental status change.

#### 4. Perform early endotracheal intubation

Perform early endotracheal intubation. Participants may accomplish this critical action by performing endotracheal intubation within the first two minutes of the case. If endotracheal intubation is not initiated within the first two minutes of the patient's arrival, then cricothyroidotomy will be necessary to stabilize the patient and optimize the patient's oxygenation and ventilation.

Cueing Guideline: The nurse asks if the doctor about the patient's concerning oxygen saturation, respiratory status, and upper airway (presence of soot), and if anything could be done to improve the patient's status.

#### 5. Obtain appropriate consultations

Obtain appropriate consultations. Depending on the specific institutional capabilities, participants will meet this critical action by requesting consultation with the Poison Center/Toxicologist, Burn Center specialist, Hyperbaric specialist, Clinical Pharmacologist, and/or the Intensivist.

Cueing Guideline: The nurse asks if the doctor needs to discuss the case with any consultants.

**6. Administer hydroxocobalamin (preferred) or equivalent (sodium thiosulfate)**

Administer hydroxocobalamin (preferred) or equivalent (sodium thiosulfate). A discussion with the Poison Center/Toxicologist, Burn Center specialist, or Clinical Pharmacist will facilitate dosing if participants require assistance. The Clinical Pharmacist and/or Poison Center/Toxicologist will recommend hydroxocobalamin as the favored intervention over sodium thiosulfate; the use of nitrites will be discouraged.

Cueing Guideline: The nurse can ask if there are any antidotes that could help stabilize this patient.

**7. Admit/transfer to the MICU/Burn Center for definitive care**

Admit/transfer to the MICU/Burn Center for definitive care. A discussion with the intensivist or the Burn Center specialist regarding admission/transfer is required prior to the completion of the case. Request for transfer to a Hyperbaric Center will be refused by the Hyperbaric specialist on the basis that the “carboxyhemoglobin” level is not likely the cause for the patient’s symptoms (especially if the cyanide exposure has not been discovered).

Cueing Guideline: The nurse can ask if there is a definitive disposition for the patient yet.

## Critical Actions Checklist<sup>1</sup>

Resident Name								
Case Description								
<b>Skills measured</b> <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>	<b>Very Unacceptable</b>		<b>Unacceptable</b>		<b>Acceptable</b>		<b>Very Acceptable</b>	
<b>Data Acquisition (D)</b> PC MK I	1	2	3	4	5	6	7	8
<b>Problem Solving (S)</b> PC MK PB	1	2	3	4	5	6	7	8
<b>Patient Management (M)</b> PC MK IC P PB SB	1	2	3	4	5	6	7	8
<b>Resource Utilization (R)</b> PC PB SB	1	2	3	4	5	6	7	8
<b>Health Care Provided (H)</b> PC SB	1	2	3	4	5	6	7	8
<b>Interpersonal Relations (I)</b> IC P	1	2	3	4	5	6	7	8
<b>Comprehension of Pathophysiology (P)</b> MK PB	1	2	3	4	5	6	7	8
<b>Clinical Competence (C)</b> PC MK IC P PB SB	1	2	3	4	5	6	7	8
Critical Actions								
<b>Yes</b>	<b>No</b>				<b>Comments:</b>			
		Identify metabolic acidosis						
		Place on cardiac monitor						
		Order serum carboxyhemoglobin level and point-of-care glucose						
		Provide early endotracheal intubation						
		Obtain appropriate consultations						
		Administer hydroxocobalamin or equivalent						
		Admit/transfer to the MICU/Burn Center for definitive care						
		<b>Yes</b>	<b>No</b>	<b>Dangerous actions</b>				

<sup>1</sup> Modified ABEM Oral Certification Examination checklist and scoresheet



**For Examiner Only**

**STIMULUS INVENTORY**

- #1 Complete blood count
- #2 Basic metabolic panel
- #3 Urinalysis
- #4 Liver function tests
- #5 A: Initial arterial blood gas  
B: Repeat arterial blood gas
- #6 Toxicology
- #7 Coagulation studies
- #8 Carboxyhemoglobin
- #9 Lactate
- #10 CXR

**For Examiner Only****LAB DATA & IMAGING RESULTS**

<b>Stimulus #1</b>	
<b>Complete Blood Count (CBC)</b>	
WBC	10,700/mm <sup>3</sup>
Hemoglobin	13.5 g/dL
Hematocrit	39.5%
Platelets	297,000/mm <sup>3</sup>
Differential	
PMNLs	75%
Lymphocytes	22%
Monocytes	2%
Eosinophils	1%

<b>Stimulus #2A</b>	
<b>Basic Metabolic Panel (BMP)</b>	
Sodium	147 mEq/L
Potassium	4.5 mEq/L
Chloride	108 mEq/L
Bicarbonate	12 mEq/L
Glucose	162 mg/dL
BUN	22 mg/dL
Creatinine	1.0 mg/dL
Calcium	8.5 mEq/L

<b>Stimulus #3</b>	
<b>Urinalysis</b>	
Color	Yellow
Specific gravity	1.030
Glucose	Negative
Protein	Negative
Ketones	Negative
LE/Nitrites	Negative
Blood	Negative
WBC/RBC	0/hpf / 0/hpf
Crystals/bacteria	Negative

<b>Stimulus #4</b>	
<b>Liver Function Tests</b>	
AST	49 IU/L
ALT	32 IU/L
ALP	110 IU/L
T. Bilirubin	1.2 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL

<b>Stimulus #5</b>		
<b>Arterial Blood Gas (Initial/Repeat)</b>		
pH	7.15	7.10
pCO <sub>2</sub>	30 mmHg	32 mmHg
pO <sub>2</sub>	100 mmHg	350 mmHg
HCO <sub>3</sub>	12 mEq/L	10 mEq/L
Base deficit	17	17

<b>Stimulus #6</b>	
<b>Toxicology</b>	
APAP / ASA	Undetectable
Ethanol	Undetectable

<b>Stimulus #7</b>	
<b>Coagulation Studies</b>	
PTT	28 seconds
INR	0.99

<b>Stimulus #8</b>	
<b>Carboxyhemoglobin</b>	
Value	10%

<b>Stimulus #9</b>	
<b>Lactate</b>	
Value	10.7

<b>Stimulus #10</b>	
CXR (see stimulus)	

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

WBC	10,700/mm <sup>3</sup>
Hemoglobin	13.5 g/dL
Hematocrit	39.5%
Platelets	365,000/mm <sup>3</sup>
Differential	
PMNLs	75%
Lymphocytes	22%
Monocytes	2%
Eosinophils	1%

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

Sodium	147 mEq/L
Potassium	4.5 mEq/L
Chloride	108 mEq/L
Bicarbonate	12 mEq/L
Glucose	162 mg/dL
BUN	22 mg/dL
Creatinine	1.0 mg/dL
Calcium	8.5 mEq/L

**Stimulus #3****Urinalysis**

Color / pH	Yellow
Specific gravity	1.030
Glucose	Negative
Protein	Negative
Ketones	Negative
LE/Nitrites	Negative
Blood	Negative
WBC/RBC	0/hpf / 0/hpf
Crystals/bacteria	Negative

**Stimulus #4****Liver Function Tests**

AST	49 IU/L
ALT	32 IU/L
ALP	110 IU/L
T. Bilirubin	1.2 mg/dL
D. Bilirubin	0.2 mg/dL
Albumin	4.3 mg/dL

**Stimulus #5A****Arterial Blood Gas #1**

pH	7.15
pCO <sub>2</sub>	30 mmHg
pO <sub>2</sub>	100 mmHg
HCO <sub>3</sub>	12 mEq./L
Lactate	17

**Stimulus #5B****Arterial Blood Gas #2**

pH	7.10
pCO <sub>2</sub>	32 mmHg
pO <sub>2</sub>	350 mmHg
HCO <sub>3</sub>	10 mEq/L
Lactate	17



**Stimulus #6**

**Toxicology**

APAP / ASA	Undetectable
Ethanol	Undetectable

**Stimulus #7**

**Coagulation Studies**

PTT	28 seconds
INR	0.99

**Stimulus #8**

**Carboxyhemoglobin**

Value	10%
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**Stimulus #9**

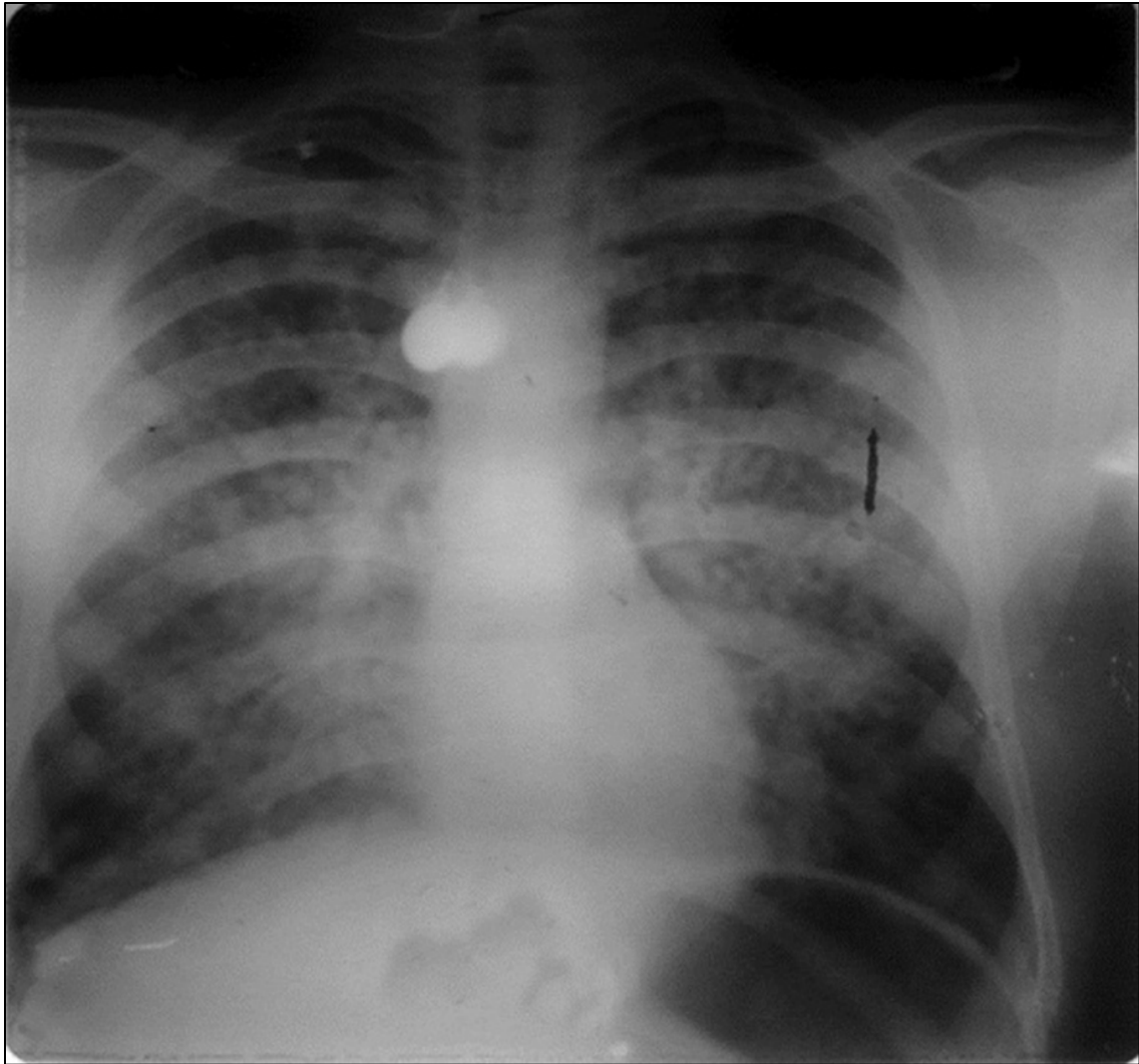
**Lactate**

Value	10.7
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**Stimulus #10**

**CXR**

([http://america.pink/acute-inhalation-injury\\_244614.html](http://america.pink/acute-inhalation-injury_244614.html). Accessed 11 May 16)



## **Debriefing Materials – Cyanide Toxicity**

**Educational Goal:** To review the key principles of cyanide toxicity recognition and management.

### **Debriefing Method**

- I. Decompress – “How did you feel it went?” (not asking for details; just a chance for the resident to decompress, decrease anxiety/energy level to be more open to learning/retaining knowledge)
- II. Core Medical Knowledge (instructor covers details of scenario and objectives)
- III. Advocacy/Inquiry
  - a. As an instructor “advocate” for your point of view/observations of resident action
  - b. Inquire with an open mind to see why the resident acted the way they did – use this response as a springboard to determine what exactly to teach (e.g., was the resident’s poor performance due to missing core medical knowledge or is it a lack of communication skills with the rest of the team?)
- IV. Plus/Delta
  - a. Plus – tell the resident what went well
  - b. Delta – Tell the resident what she could change for next time

### **Introduction:**

CO and CN are both highly toxic lethal compounds. Smoke inhalation victims, such as the patient in this case, present a major challenge as they may have been exposed to either or both CO and CN.

### **Sources of Exposure:**

- CO poisoning are much more likely to occur in winter in areas with colder climate due to defective household heating sources and improper use of cooking equipment in enclosed spaces.
- Cyanide poisoning is most often linked to house fires and combustion of products containing carbon and nitrogen, primarily foam rubber, wool, plastics, and other synthetic materials.

### **Pathophysiology:**

#### **CO**

- CO is an odorless, tasteless, colorless gas that is created with incomplete combustion of fuels.
- CO is inhaled in the lungs, diffuses across alveolar barriers, and binds to hemoglobin to form carboxyhemoglobin.
- CO has an affinity for hemoglobin 210 times higher than O<sub>2</sub> leading to leftward shift on the hemoglobin-oxygen dissociation curve. This leads to decreased release of oxygen from hemoglobin resulting in cellular hypoxia.
- CO also inhibits O<sub>2</sub> supply to mitochondria in myocardial cells, causing injury to the myoglobin.
- The systems most affected by CO include those most affected by hypoxia: heart and CNS.
  - Treatment for CO poisoning is oxygen! O<sub>2</sub> competitively displaces CO from hemoglobin.
    - Room air, this process takes 300 minutes.

- 100% nonrebreather mask, process decreased to 60-90 minutes.
- Hyperbaric oxygen therapy, process decreased to 30 minutes.

## CN

- CN disrupts the electron transport chain in the mitochondrial production of ATP by binding to and inhibiting cytochrome oxidase a.
- As aerobic cellular metabolism ceases, cells are forced into anaerobic metabolism with the subsequent generation of lactate.
- This causes profound acidosis and very elevated lactate levels, quickly resulting in cellular death.
- Similar to CO toxicity, the most quickly and severely affected organs are the heart and CNS.

## Signs and Symptoms:

- CO:
  - 10-20: headache, fatigue, nausea, shortness of breath
  - 20-40: Irritability, impaired judgment, vertigo, chest pain
  - 40-50: Confusion, LOC
  - 50+: Medical examiner cutoff for CO as cause of death
  - 60-70: Unconsciousness, seizures, CV collapse, stroke, and death.
  - 80+: Rapidly fatal
- CN:
  - Mild: Nonspecific complaints such as headache, nausea, vertigo, anxiety, altered mental status, hypertension.
  - Severe: Unconsciousness, seizures, cardiovascular collapse such as shock, pulmonary edema, and ultimately death.

## Diagnostic Testing:

- Standard pulse oximetry
  - Unreliable as it does not distinguish between wavelengths caused by refractions of hemoglobin vs. carboxyhemoglobin vs. methemoglobin.
- Bedside pulse co-oximetry
  - Able to distinguish waveform types
  - Bedside so easily accessible and near instant results
  - Inconsistently reliable readings. Rule of thumb: If elevated, proceed under assumption true level is that reading or even higher. If normal, confirm with blood test level.
- Carboxyhemoglobin levels:
  - Normal: 2-5% in nonsmokers, 5-13% in smokers
  - Pregnant women require special consideration as fetal hemoglobin may be present and as high as 30% at 3 months, which translates to a carboxyhemoglobin level of approximately 7%.
  - Dangerous levels are considered those > expected values with level >25% utilized as indication for hyperbaric therapy.
  - Keep in mind normal carboxyhemoglobin levels may be present in those who have already received oxygen (e.g., from EMS) or as time passes from exposure to time of checking level.
- Lactate levels:
  - Within normal limits or mild elevation, more consistent with CO poisoning alone.
  - Aids clinical diagnosis with rule of thumb for diagnosis of CN toxicity of:

- Lactate > 8 mmol/L in victims without smoke inhalation
  - Lactate > 11 mmol/L in victims with concomitant smoke inhalation
- CBC:
  - Mild leukocytosis may be seen with CO poisoning
- VBG:
  - Normal to elevated PaO<sub>2</sub> level (very high levels of PaO<sub>2</sub> suggestive of CN poisoning, reflection of cell's inability to extract and use oxygen)
  - Mild acidosis with CO poisoning, Severe acidosis with CN poisoning.
- Cardiac biomarkers:
  - Myocardial infarction is due to direct CO myocardial toxicity and is prognostic for in-hospital fatality.
  - May also be elevated secondary to ischemia from hypoxia or from ischemia with lactic acidosis.
- Obtain hepatic, renal, and coagulation profiles, as well as creatinine kinases levels to address possible underlying end organ dysfunction in patients with moderate-to-severe toxicity

#### **Treatment:**

- CO exposure/toxicity
  - Remove victim from scene ASAP.
  - Immediately administer 100% O<sub>2</sub> via nonrebreather mask, noninvasive positive pressure ventilation, or endotracheal ventilation.
  - Goal of oxygen intervention is a carboxyhemoglobin level <5%.
  - Hyperbaric oxygen therapy is indicated if there is any of the following: end-organ injury (e.g., myocardial infarction, seizure), LOC at scene, carboxyhemoglobin level >25%, level >15% in pregnant women, neurological deficits, ongoing symptoms (e.g., chest pain, altered mental status). Consider HBO also if the patient is older (age >50), or has ongoing symptoms despite 100% O<sub>2</sub>.
  - Hyperbaric research is somewhat controversial at this time. Proponents argue there is a decrease in long-term neuropsychiatric sequelae.
  - In 2008, ACEP issued a level C recommendation for hyperbaric therapy for CO toxicity.
- CN exposure/toxicity
  - Similar to CO, immediate removal from source.
  - Antidote use: choice of antidote (hydroxocobalamin or sodium thiosulfate) is often institution-specific. Several studies suggest both are efficacious for treating CN poisoning.
  - Amyl/sodium Nitrite should not be administered in this case due to concomitant CO poisoning.
  - Hydroxocobalamin administration may result in flushing, hypertension, and problems with interpretation of laboratory results that use colorimetric testing.
- As with all patients, remember to assess and manage concomitant injuries, for example possible traumatic injuries.

#### **Consultations:**

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



- Hyperbaric therapy may be considered for CO poisoning with:
  - Carboxyhemoglobin level >25%
  - Evidence of cardiac involvement
  - Severe acidosis
  - Transient or prolonged unconsciousness
  - Neurologic impairment (for example, seizures as present in this case)
  - Patients 36 years of age or older
  - Pregnant women

**Disposition:**

- Admit patients with major signs and symptoms to an ICU.
- Consult and consider admission or transfer to hyperbaric unit when indicated.

**Take-Home Points:**

- CO and CN toxicity can both be present in victims of smoke inhalation.
- Medical providers must always maintain a high index of suspicion for these toxic compounds in all victims of smoke inhalation.
- CO poisoning can be diagnosed with detection of carboxyhemoglobin levels in blood or bedside point of care co-oximetry.
- Carboxyhemoglobin level does not correlate with level of severity of toxicity.
- CN toxicity remains a clinical diagnosis and there is no specific and quick bedside lab confirmatory test, although lactate levels assist greatly.
- Blood lactate levels > 8 mmol/L in non-smoke inhalation victims and > 11 mmol/L in smoke inhalation victims are considered diagnostic of CN toxicity.
- Initial treatment for CO exposure/toxicity is administration of 100% oxygen.
- Hyperbaric oxygen is an adjunct treatment which should be considered but benefits of hyperbaric therapy remain controversial.
- CN treatment options include hydroxocobalamin, sodium thiosulfate, and amyl/sodium nitrite.
- Both hydroxocobalamin and sodium thiosulfate can be given with suspected concomitant CO and CN toxicity; however, amyl and sodium nitrites can cause methemoglobinemia and hypotension and are, therefore, not recommended with concomitant CO poisoning.

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