CARBON MONOX1DE POISONONING AND OUR EXPERIENCES

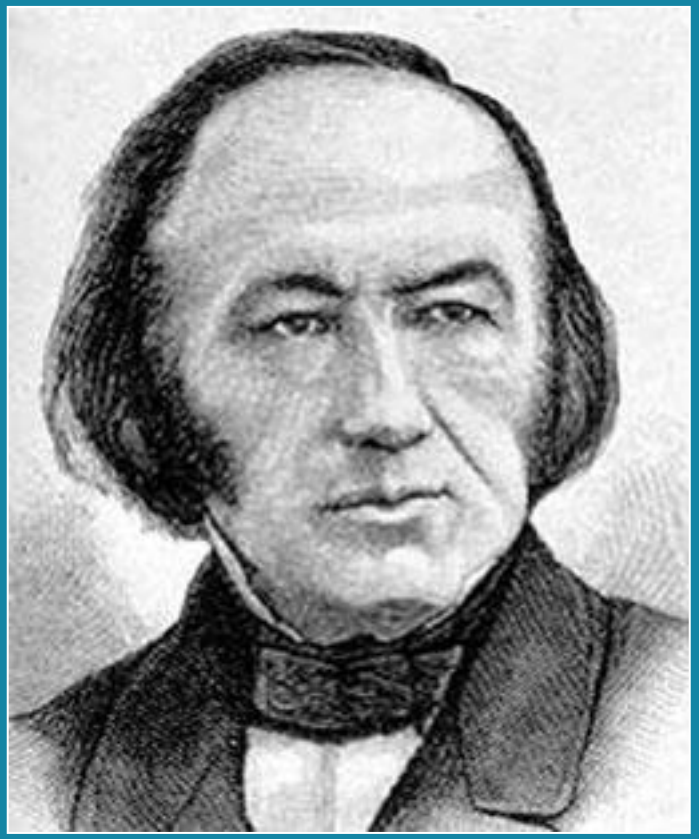
Dr. Behçet Al
ED of Medicine School, Gaziantep University, Gaziantep/Turkey, 2017

No Conflict of Interest

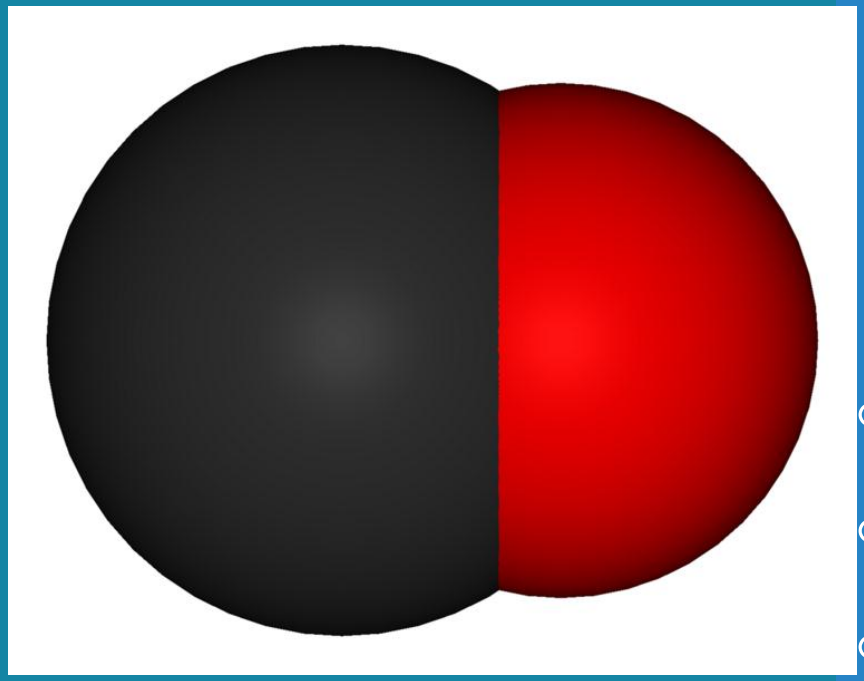
- Definition,
- Pathophysiology
- Sources
- Clinical presentation,
- Management
- **CO poisoning in Turkey**

Carbon Monoxide

- Significantly more is known about CO poisoning since Claude Bernard described it in 1857.
  - Bernard C. *Lecons sur les Effets des Substaces Toxiques et Medicamenteuses*. Paris: J-B Bailliere et Fils, 1857



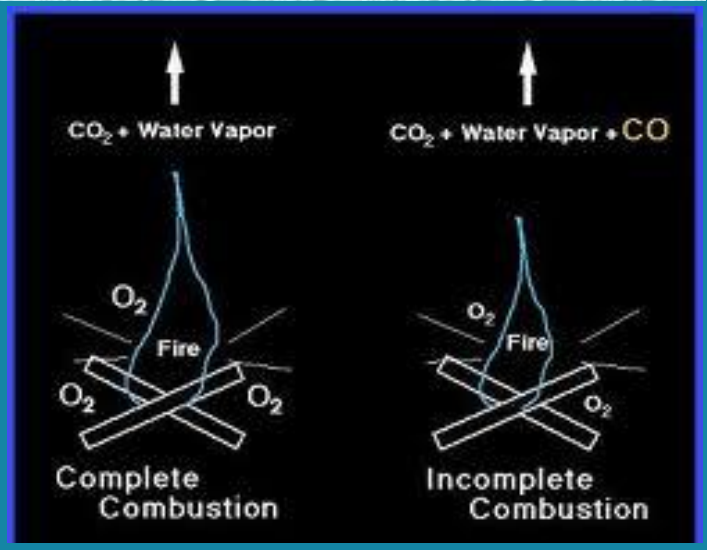
What Is Carbon Monoxide?



- CO is a compound of Carbon and Oxygen
  - One atom carbon to one atom oxygen
- Colorless
- Odorless
- Tasteless
- POISONOUS Gas
- **KILLING GAS**

Where Does It Come From?

- CO is Produced by the Incomplete Combustion of Various Fuels (Hydrocarbons) , Including:
  - **Coal**
  - Wood
  - **Charcoal**
  - Oil
  - Kerosene
  - Propane
  - Natural Gas



- Reaction That Does Not Convert All of a Fuel's Carbon and Hydrogen Into Carbon Dioxide and Water, Respectively

Sources of Carbon Monoxide

Endogenous

- Normal heme catabolism:
  - Only biochemical reaction in the body known to produce CO.
- Levels increased in:
  - Hemolytic anemia.
  - Sepsis

Exogenous

House fires.

Gas–powered electrical generators.

Automobile exhaust.

Propane-powered vehicles.

Heaters.

Camp stoves

Boat exhaust.

Cigarette smoke.

Methylene chloride

Incidence

- Responsible for half of all poisonings worldwide.
- ~40,000–50,000 ED visits annually
- In-hospital mortality: 5%

TABLE 1. Unintentional, non–fire-related deaths from carbon monoxide (CO) poisoning,* by age group, sex, and race/ethnicity — United States, 1999–2004

Characteristic	Total deaths No.	(%)	6-year average annual crude rate†	6-year average annual rate†	(95% CI§)
Total	2,631	(100)	1.53	1.53	(1.47–1.59)
Age group (yrs)					
0–4	52	(2)	0.45	—	—
5–14	83	(3)	0.33	—	—
15–24	256	(10)	1.06	—	—
25–34	322	(12)	1.35	—	—
35–44	505	(19)	1.87	—	—
45–54	472	(18)	2.00	—	—
55–64	314	(12)	2.00	—	—
≥65	628	(24)	2.13	—	—
Sex					
Male	1,958	(74)	2.32	2.41	(2.30–2.52)
Female	673	(6)	0.77	0.74	(0.68–0.79)
Race/Ethnicity¶					
White, non-Hispanic	1,941	(74)	1.65	1.54	(1.48–1.61)
Black, non-Hispanic	305	(11)	1.46	1.64	(1.45–1.83)
Other, non-Hispanic	97	(4)	0.98	1.01	(0.80–1.22)
Hispanic	279	(11)	1.25	1.31	(1.14–1.48)

* Deaths coded with *International Classification of Disease, Tenth Revision* codes T58 and X47, excluding X00–X09, X76, X97, Y26, and Y17.
† Average age-adjusted rate per 1 million persons.
§ Confidence interval.
¶ Records in which ethnicity was unknown or missing were excluded from analysis (n = 9).

Source: Hampson NB. *Am J Emerg Med.* 2005;23:838-841

Incidence in Turkey

- **Most accidental deaths are due to:**
  - House fires.
  - Indoor-heating systems.
  - **Stoves and other appliances.**
  - Gas-powered electrical generators
  - **Charcoal grills.**
  - Water heaters.

Pathophysiology Summary

- **Limits O_2 transport:**
  - CO more readily binds to Hb forming COHb.
- **Inhibits O_2 transfer:**
  - CO changes structure of Hb causing premature release of O_2 into the tissues.
- **Tissue inflammation**:
  - Poor perfusion initiates an inflammatory response.

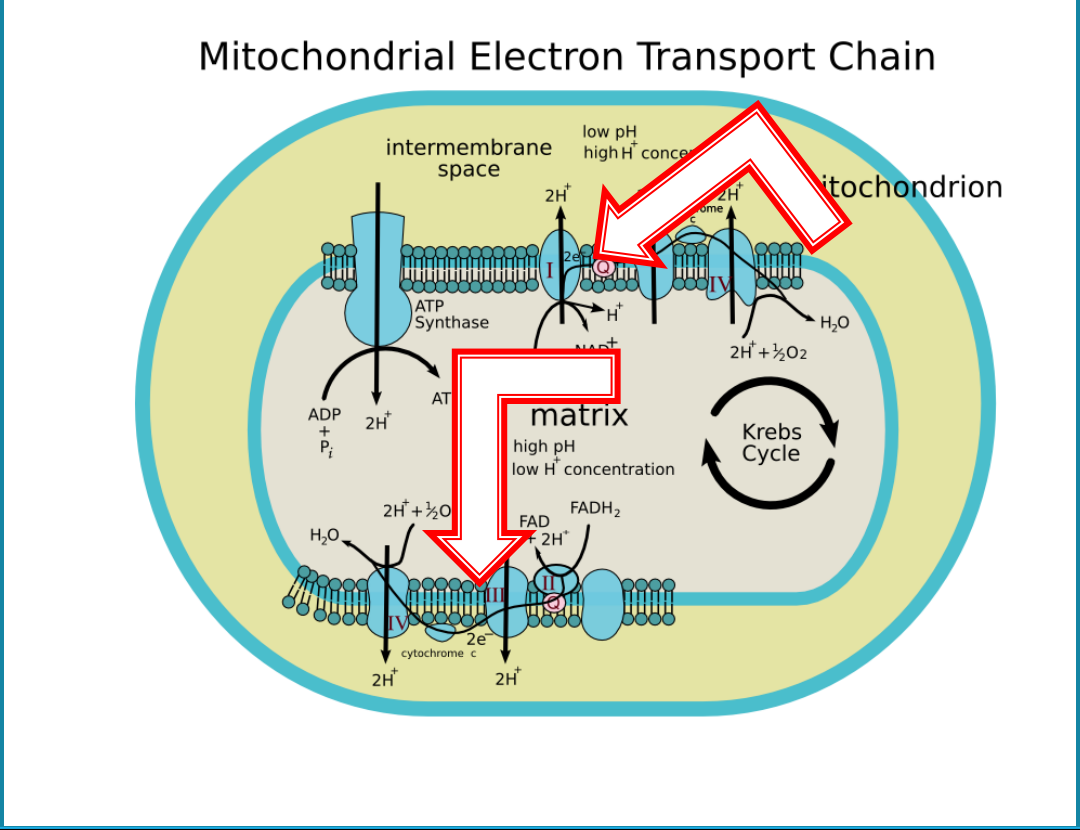
Pathophysiology Summary

- **Free radical formation:**
  - NO accelerates free radical formation.
  - Endothelial and oxidative brain damage.

Increased activation of nitric oxide (NO):

Cerebral and Peripheral vasodilation: Syncope, Headache
Inflammatory response.
Systemic hypotension
Reduction in cerebral blood flow

Inhaled CO may interrupt myocardial oxidative phosphorylation by decreasing the activity of myocardial cytochrome oxidase (CcOX), the terminal oxidase in the electron transport



Source: Suner S, Jay S. *cad Emerg Med*. 2008;15:59-65

Impact of CO on major body systems:

- **Cardiac**:
  - Decreased myocardial function:
    - Hypotension with tachycardia.
    - Chest pain.
    - Dysrhythmias.
    - Myocardial ischemia.
    - Most CO deaths are from ventricular fibrillation.
- **Metabolic**:
  - Respiratory alkalosis (from hyperventilation).
  - Metabolic acidosis with severe exposures.
- **Respiratory**:
  - Pulmonary edema (10-30%)

Delayed Neurologic Syndrome

- **Signs and Symptoms:**
  - Memory loss
  - Confusion
  - Ataxia
  - Seizures
  - Urinary incontinence
  - Fecal incontinence
  - Emotional lability
- **Signs and Symptoms:**
  - Disorientation
  - Hallucinations
  - Parkinsonism
  - Mutism
  - Cortical blindness
  - Psychosis
  - Gait disturbances
  - Other motor disturbances

- Behavioral and neurological deterioration 2-40 days later.
- True prevalence uncertain (1-47%)
- More common when there is a loss of consciousness in the acute poisoning.

Patient Groups at Risk

- Children.
- Elderly.
- Persons with heart disease.
- Pregnant women.
- Patients with increased oxygen demand.
- Patients with decreased oxygen-carrying capacity (i.e., anemias, blood cancers).
- Patients with chronic respiratory insufficiency.

Signs and Symptoms (Acute)

- Malaise
- Flu-like symptoms
- Fatigue
- Dyspnea on exertion
- Chest pain
- Palpitations
- Lethargy
- Confusion
- Depression
- Coma
- Impulsiveness
- Distractibility
- Hallucination
- Confabulation
- Agitation
- Nausea
- Vomiting
- Diarrhea
- Abdominal pain
- Death
- Headache
- Drowsiness
- Dizziness
- Weakness
- Confusion
- Visual disturbances
- Syncope
- Seizures
- Fecal incontinence
- Urinary incontinence
- Memory disturbances

CO Poisoning

- Signs and symptoms closely resemble those of other diseases.
- Often misdiagnosed as:
  - Viral illness (e.g., the "flu")
  - Acute coronary syndrome
  - Migraine

Estimated that misdiagnosis may occur in up to 30-50% of CO-exposed patients presenting to the ED.

Raub JA, et. *Toxicology* 2000;145:1-14

Treatment

- Treat complications (i.e., seizures, dysrhythmias, cardiac ischemia).
- Administration high-concentration oxygen and maximizing hemoglobin oxygen saturation is associated with improvements in neurological and cardiac complications.
- Prehospital CPAP is *strongly suggested* for moderate to severe poisonings.

Source: Jones A, Recent Advances in the Management of Poisoning. *Ther Drug Monit* 2002;24:150-155

Indications for HBO Therapy

Strongly consider for:

- Altered mental status.
- Coma.
- Focal neurological deficits.
- Seizures.
- Pregnancy with COHb>15%.

Possibly consider for:

- Cardiovascular compromise (e.g., ischemia, dysrhythmias).
- Metabolic acidosis.
- Extremes of age.

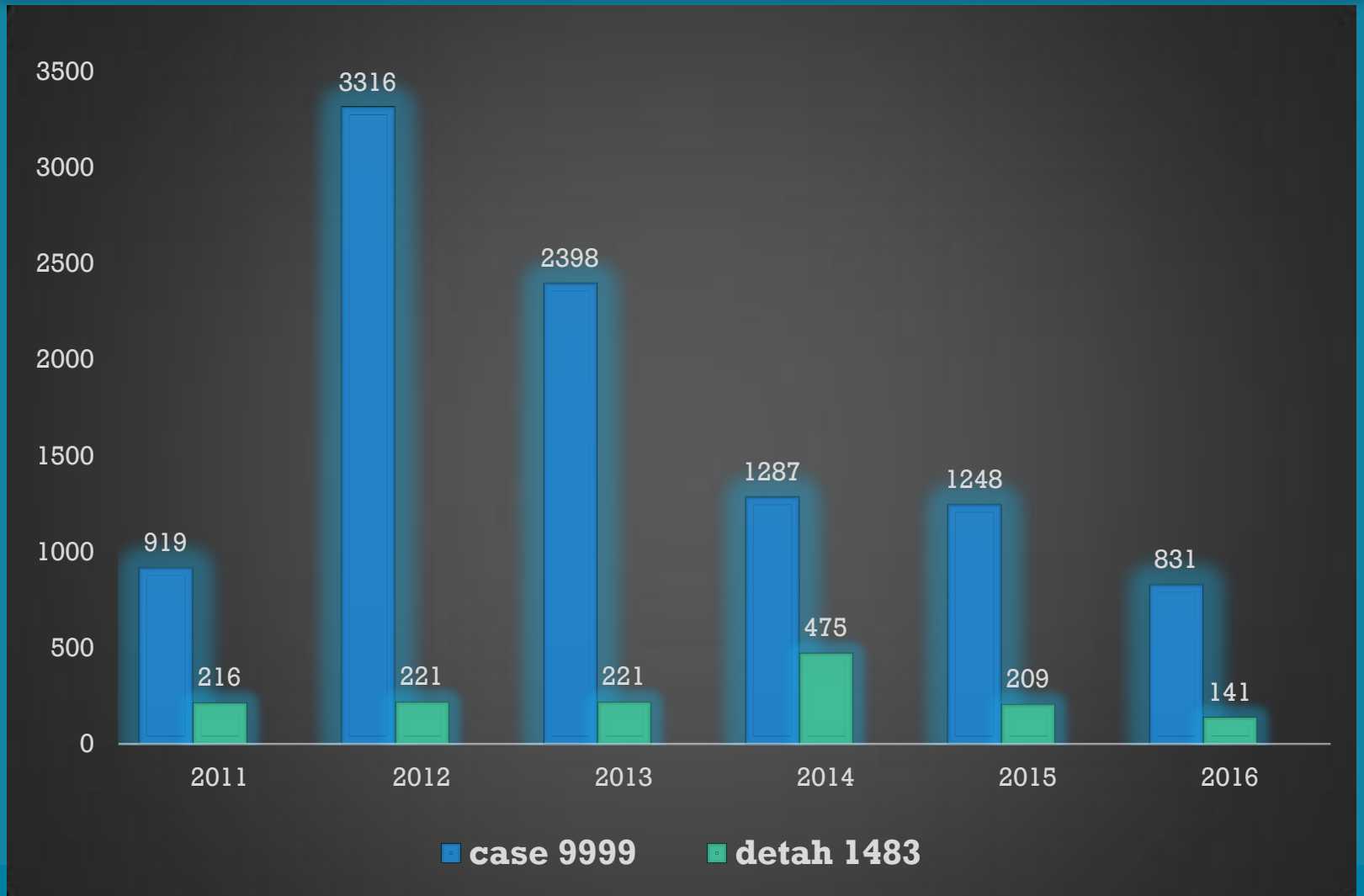
May aid in alleviating tissue hypoxia.
Significantly decreases half-life of COHb.



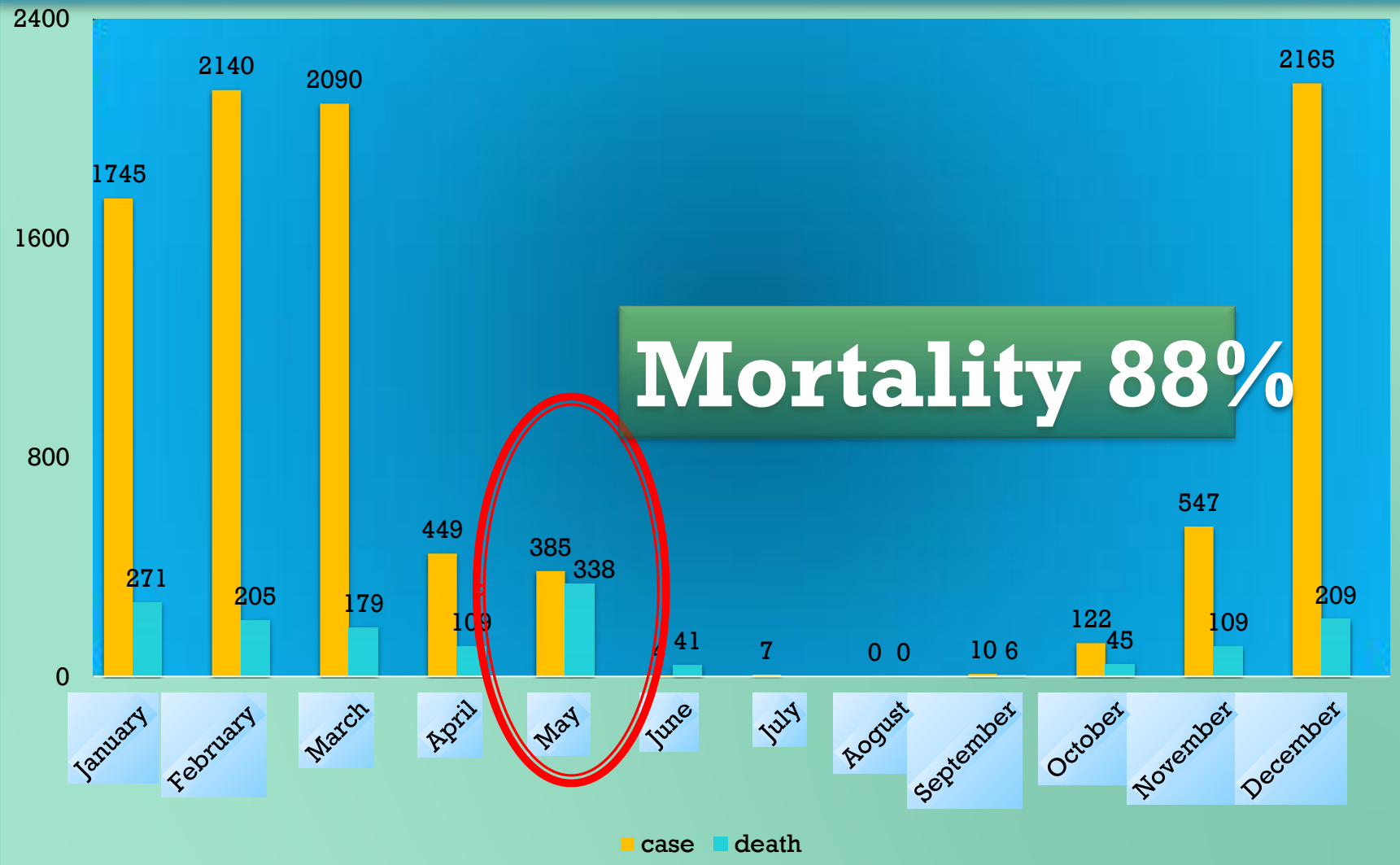





CO Poisonin between 2011-2016 in Turkey (moderate and severe ptn)



CO Poisonin between 2011-2016 in Turkey



metal quarry accident

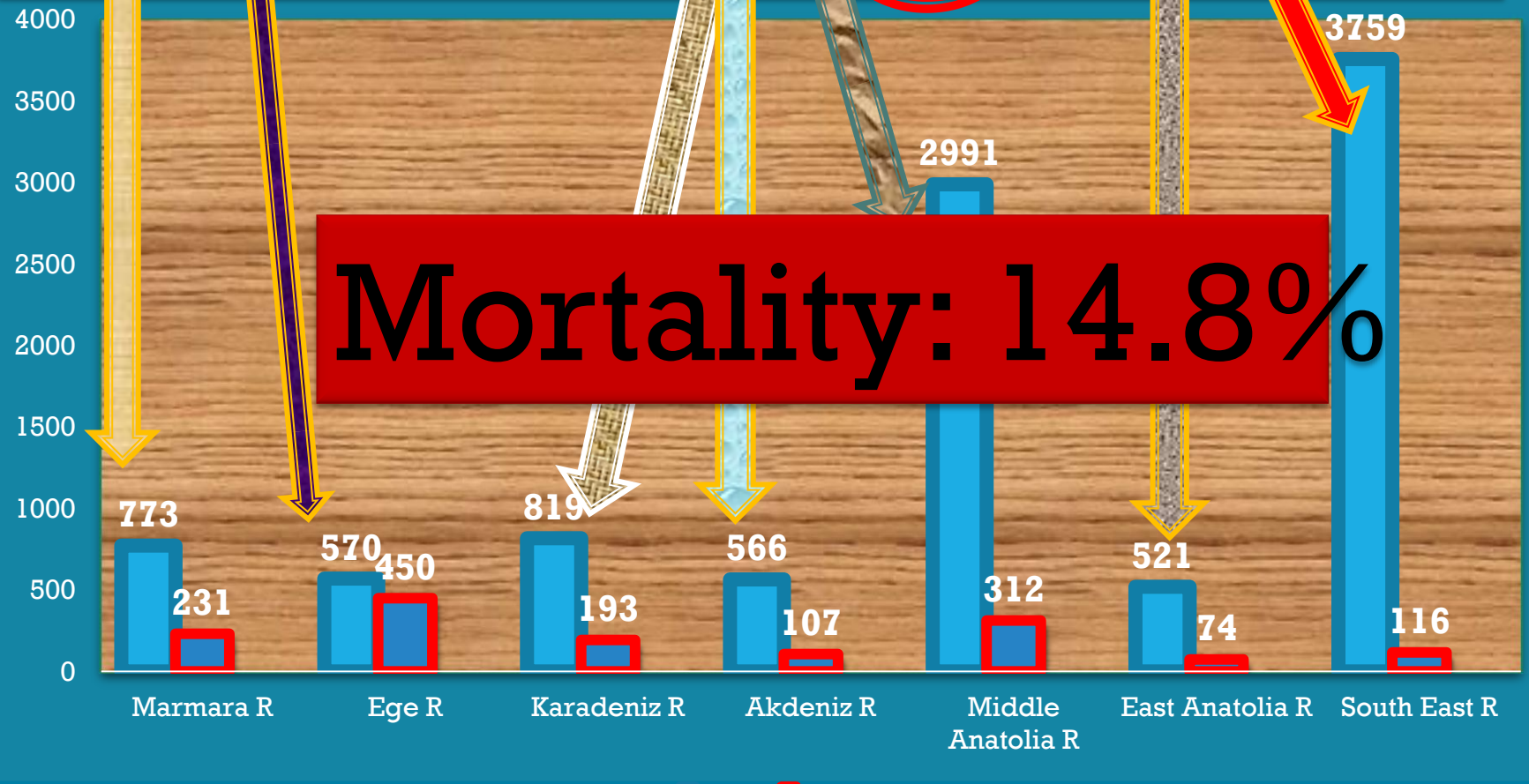
May 2014
301 deaths

Bulgaristan
Sakarya
Ankara
Yozgat
Eskişehir
Manisa
İzmir
Muğla
Egeo

So

- Chimney-based toxicity data in our country is well above the European average.
- The basic sourse of CO poisoning and death is warm up in our country
- However, there is a serious drop in the number of poisoning-deaths, especially in 2016.
- The reason for this may be the late start of the heating season, depending on the climate change.
- However, this data shows regional differences.

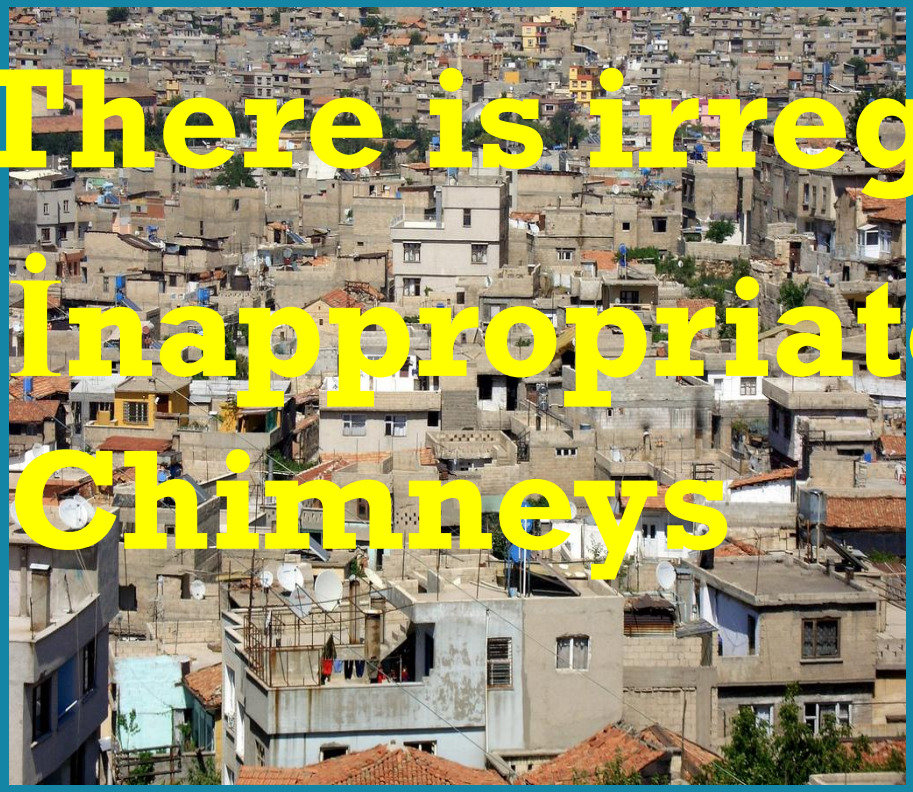
Mortality: 14.8%

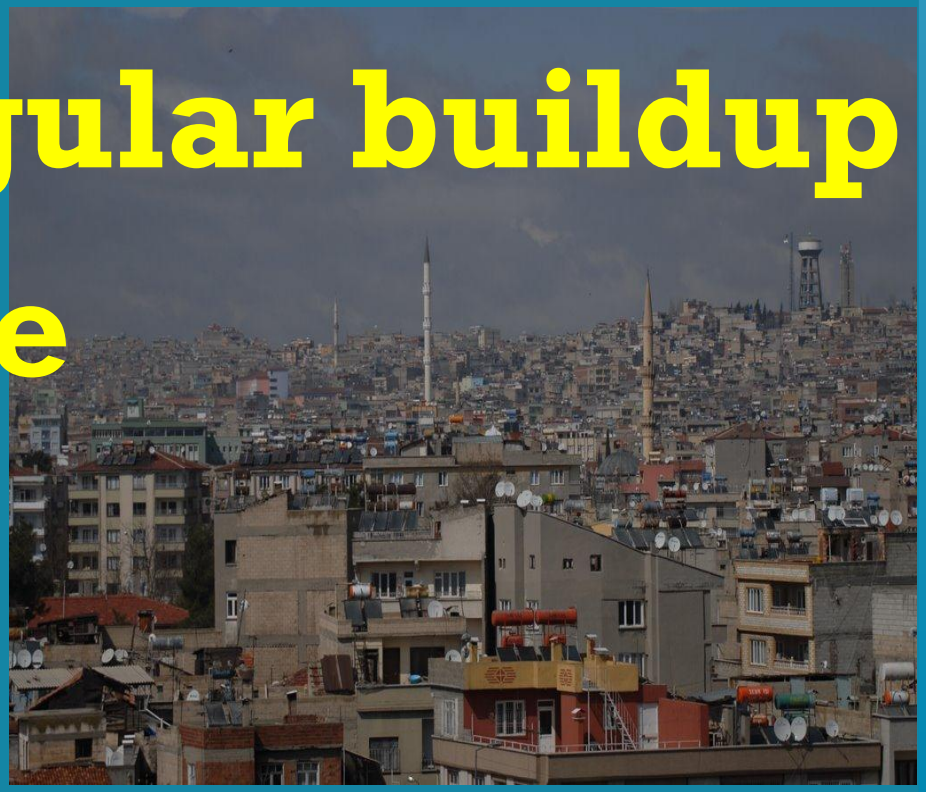


Gaziantep	Case	Death
2011		
2012	1624	15
2013	**914 (879)**	**15**
2014	1053	11
2015	1184	15
2016	1186	10
Total	**5961**	**66**

27%

Lodos wind





There is irregular buildup

Inappropriate Chimneys

Natural gas usage is minimal

Housewifes

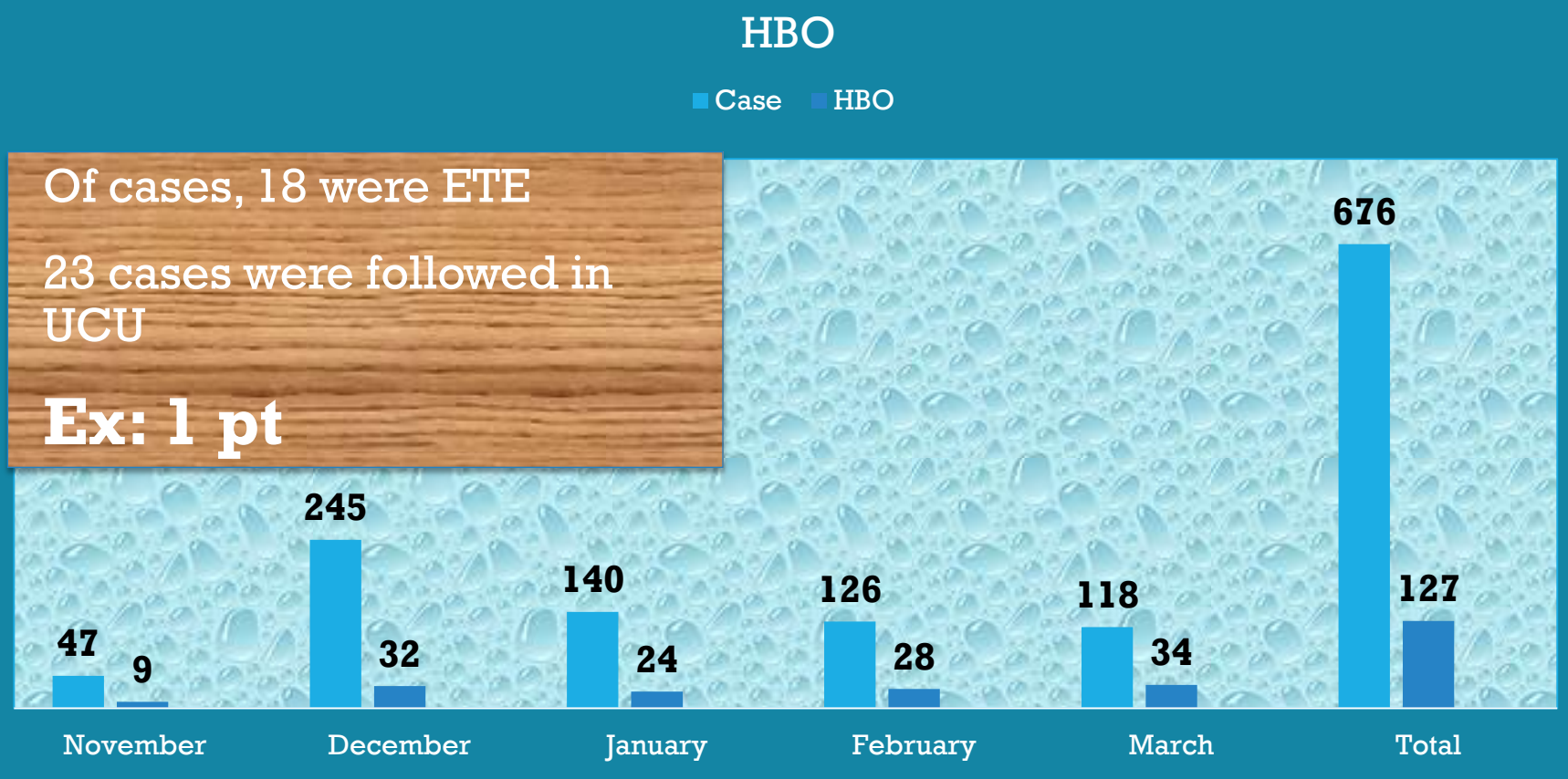
Gaziantep		Female %	Male %	Mortality n
2012	1624	**59**	41	15
2013	914	**60**	40	15
2014	1053	**57**	43	11
2015	1184	**62**	38	15
2016	1186	**61**	39	10
Total	5961	**60%**	40%	66

Mortality 11%

HBO and CO exposue

November 2016 and March 2017 (five months)

Patients diagnosed with the code "T58 - Toxic Effect of Carbon Monoxide" according to the International Classification of Diseases Version 10 (ICD-10) coding system.



Gender	Case	Mean age
Male	56	36,66(3-87)
Female	71	40,07 (1-92)
Total	127	38,56

GCS		
13-15	Mild	98
9-12	Moderate	7
3-8	Severe	22

Source	Case
Stove	120
Fire	1
Natural gas	6
Total	127

94%

Gaziantep	Case	Death n (%)
Stove	9038	953 (11)
Combi	317	39 (12.3)
Water heater	96	50 (52)
Barbecue	366	182 (50)
Total	9817	1224 (12,5)

Türk Biyokimya Dergisi [Turkish Journal of Biochemistry–Turk J Biochem] 2012; 37 (1) ; 283–289.
doi: 10.5505/tjb.2012.65365

Research Article [Araştırma Makalesi]

Yayın tarihi 30 Mart, 2012 © TurkJBiochem.com
[Published online 30 March, 2012]

The effect of chronic carbon monoxide exposure on hs-CRP, CIM thickness and PEF in furnacemen

Table 1. The comparison of lipid profile, age, CIMT, COHb, hs-CRP and PEF percentage in groups

	Study Group (n = 47)	Control Group (n = 48)	P
Age (Year)	35.3 ±3.9	34.7 ±6.5	>0.05
BMI (Kg/m)	24.6 ±5.9	25.4 ±6.0	**>0.05**
BP (mmHg)	125.8 ±15.2/79.4 ±12.6	124.5 ±13.7/77.3 ±11.3	**>0.05**
TC (mg/dL)	169.0 ±31.8	169.0 ±31.9	**>0.05**
LDL-C (mg/dL)	101.5 ±26.1	99.5 ±32.8	**>0.05**
HDL-C (mg/dL)	39.8 ±8.4	39.2 ±15.2	>0.05
TG (mg/dL)	159.1 ±78.8	164.9 ±72.7	**>0.05**
CIMT (mm)	1.11 ±0.32	0.91 ±0.11	<0.001
COHb (%)	4.5 ±1.5	2.0 ±1.1	<0.001
hs-CRP (mg/L)	3.2 ±2.1	1.1 ±0.8	<0.001
PEF (%)	93 ±3.3	98.5 ±1.8	<0.001

[1]Measured PEF (L/min) /Reference value (L/min) ×100,
BMI: Body Mass Index, BP: Blood Pressure, TC: Total Cholesterol, TG: Triglyceride, LDL-C: Low Density Lipoprotein Cholesterol, HDL-C: High Density Lipoprotein Cholesterol, CIMT: Carotids Intimae Media Thickness, COHb: Carboxy-hemoglobine, hs-CRP: high sensitive C-reactive Protein, PEF: Peak Expiratory Flow

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Journal of Clinical Apheresis 00:00–00 (2013)

Therapeutic Red Cell Exchange for Severe Carbon Monoxide Poisoning

Suat Zengin,[1]* Mehmet Yılmaz,[2] Behcet Al,[1] Cuma Yildirim,[1] Erdal Yavuz,[1] and Aycan Akcali[1]

[1]Department of Emergency, Gaziantep University School of Medicine, Gaziantep, Turkey
[2]Department of Hematology, Gaziantep University School of Medicine, Gaziantep, Turkey

Background and Objective: Carbon monoxide (CO) is the most common cause of fatal poisoning worldwide. Therapeutic red cell exchange (TREX) has been used in the treatment of many different diseases. Therefore, we aimed to evaluate the efficacy of TREX on the clinical status, outcome, and discharge of patients with severe CO poisoning. **Methods:** Demographic data, clinical status, and outcomes of 12 patients that were treated with TREX for severe CO poisoning after referral to the Emergency and Hematology Departments of Gaziantep University between November 2011 and April 2012 were evaluated. **Results:** Mean carboxyhemoglobin level decreased from (59.7 ± 12.7)% (38–79%) to (17 ± 9.4)% (8–43%), and mean Glasgow Coma Scale score increased from 4 ± 1.6 (3–8) to 9.4 ± 3.5 (3–14) after TREX therapy. Five patients were admitted to the intensive care unit. Rhabdomyolysis developed in one case. Of the 12 patients, 11 were discharged alive, and one patient died. **Conclusion:** TREX may be an alternative treatment method for reducing mortality and morbidity in cases of severe CO poisoning. J. Clin. Apheresis 00:000–000, 2013.

American Journal of Emergency Medicine (2012) 30, 2104.e1–2104.e4

ELSEVIER

The American Journal of Emergency Medicine

www.elsevier.com/locate/ajem

Case Report

Compartment syndrome on a patient's forearm related to carbon monoxide poisoning

Abstract

dizziness, weakness, nausea, confusion, disorientation, and visual disturbances) also have to be emphasized, especially if they recur with a regular periodicity or in the same environment. Complications occur frequently in CO poison-

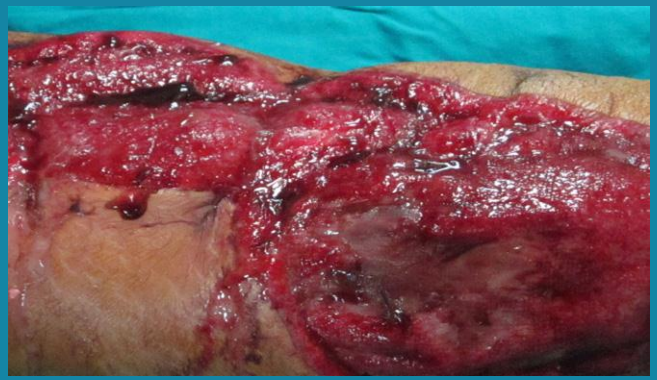


Fig. 1 Seventy-two hours postfasciotomy.

Fig. 3 Control figure 45 days postfasciotomy.

The effect of chronic carbon-monoxide exposure on the peak expiratory flow values of grill-kebab chefs.

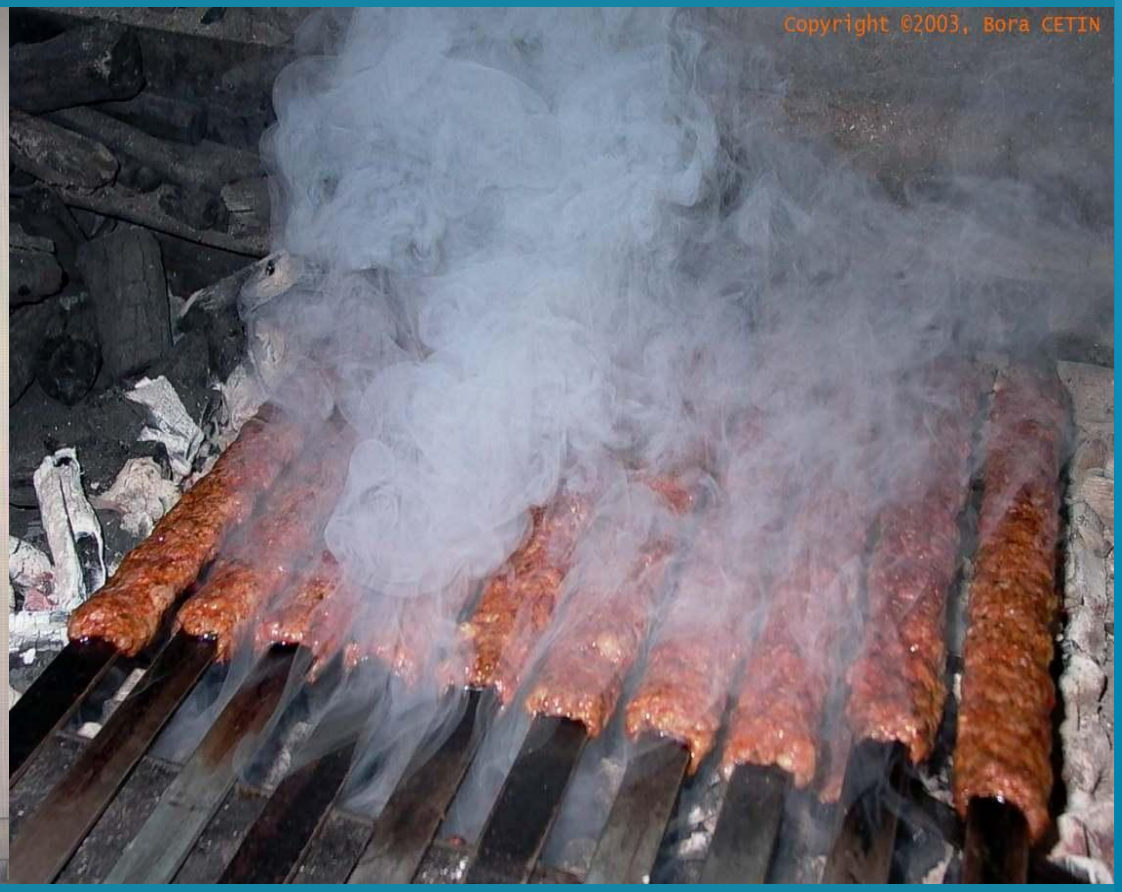
Methods: The study was carried out in Sahinbey Hospital, Medical School of Gaziantep University, Gaziantep, Turkey, between March 2007 and November 2007. Forty male grill-kebab chefs, working in restaurants for at least 3 years, and 48 non-smoker, male healthy volunteers were gathered for this study. The ages, body mass indexes (BMI), blood pressure (BP), COHb, N-terminal pro brain natriuretic peptide (NT-proBNP), and peak expiratory flow (PEF) values of the grill-kebab chefs and controls was measured. Statistical analysis was carried out using the SSPS 13.0 software.

Results: The average age for the study group was 33.0±9.1, and for the control group was 34.7±6.5 years. The average occupation time for the study group was 16.1±7.3 years. The clinical attributes, ages, BMI, BP, and NT-proBNP values of both groups were similar. The COHb (6.5±1.5/2.0±1.1%) values were higher in grill-kebab chefs compared with the control group. The NT-proBNP values were determined as normal (<60 µg/L) in both groups. A higher decrease in PEF speed (average: 65.1/7.1 L/min) was recorded in the grill-kebab chefs.

Conclusion: Chronic exposure to CO decreases PEF, with narrowing of the airway in grill-kebab chefs.

Saudi Med J 2009; Vol. 30 (6): 788-792

From the Department of Emergency (Al. Yildirim, Cavdar), Faculty of Medicine, University of Gaziantep, Gaziantep, the Department of Emergency (Zengin), Malatya State Hospital, Malatya, and the



Municipal warns the society neighberhoods under risc

Lodos wind

Appropriare stoves production

We are not vulnerable

Prevent danger from coming

Especially when to put out the barbecue

How to burn the stove

CO Detectors were distributed

- New generation oximeter/CO-oximeter can detect 4 different hemoglobin forms.
  - Deoxyhemoglobin (Hb)
  - Oxyhemoglobin (O_2Hb)
  - Carboxyhemoglobin (COHb)
  - Methemoglobin (METHb)
- Provides:
  - SpO_2
  - SpCO
  - SpMET
  - Pulse rate

CO-Oximetry

Recommendations

- The rooms where the stove, water heater, charcoal and combi work should absolutely be ventilated.
- The heatter devices must be turned off before sleeping.
- Doors must be left open as additional measures.
- Carbon monoxide detector may be supplied.
- Chimneys must be cleaned and maintained when entering winter.
- The chimney must be made in the appropriate architecture.
- Chimneys should never been cooled down.
- Chimneys should be made from steel or ceramic material which can be insulation and conform to the standards.

May minimize the mortality

- Reguler buildup
- Early detection
- Get the victims out early
- **100% oxygen adminisration (90% pts)**
- HBO Therapaty
- Thereapatic Red Cell Exchange

To create sensitivity in society