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Case presentation

# Myocardial injury triggered by combination of emotional stress and carbon monoxide poisoning

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**Abstract**

**Introduction:** Carbon monoxide (CO) is a leading cause of poisoning worldwide.Central nervous systems and the heart have the highest demand for oxygen and may be severely injured in CO poisoning.
**Case report:** A patient was referred to the emergency department after exposure to CO and strong emotional stress. On admission she was comatose with elevated lactate 14,62, metHgb 0,3% and carboxyhemoglobin 12,9%. Electrocardiogram showed sinus rhythm, 100 beats/min, poor R wave progression with inverted T waves in V1-V3 leads, biphasic T waves in V5 and V6. Transthoracic echocardioography showed left ventricle with akinetic apex and all apical segments of the left ventricle with reduced systolic function. Cardiac troponin was significantly elevated; coronary angiography showed normal coronary arteries without culprit lesion. Takotsubo syndrome was diagnosed. She was treated with high flow oxygen on mechanical ventilation, antiplatelet, angiotenzinconvertase inhibitors, beta blockers and statin therapy with complete recovery. After one month ehocardiography showed left ventricle normal in size and function.
**Conclusion:** CO poisoning hasn't yet been described as a trigger for Takotsubo syndrome. We propose that two risk factors CO poisoning and stress by may have initiated a catecholamine surge and caused the development of this specific condition.

**Keywords** carbon monoxide poisoning, cardiotoxicity, takotsubo syndrome

## Introduction

Carbon monoxide (CO) poisoning is the most frequent type of fatal poisoning all around the world[1] and is considered as a major public health problem[2]. Natural gas heating systems may cause CO poisoning[3]. Carbon monoxide is produced by the incomplete combustion of carbon fuels, including inadequately ventilated heaters and car exhausts[4]. CO is an odourless, highly toxic gas and poisoning causes hypoxia, cell damage, and death[5].

The most important mechanism of CO toxicity is tissue hypoxia[1]. The high affinity of carbon monoxide to bind to hemoglobin molecules (200 to 240 times that of oxygen) results in displacing the oxygen and generating carboxyhemoglobin, which is not able to release the oxygen to tissues and is thereby responsible for variable degrees of hypoxia[6].

Those tissues with the highest demand for oxygen such as central nervous systems and heart are prone to injury in the acute and delayed clinical features[7]. Besides hypoxic damage, carbon monoxide produces myocardium injuries with cardiospecific mechanisms, mostly attributable to direct damage at cellular or subcellular level.

Exposure to CO is measured either directly from blood samples and expressed as a percentage of carboxyhaemoglobin or indirectly using the carbon monoxide in expired breath[4].

CO induced cardiotoxicity has many clinical manifestations including arrhythmias[8], left ventricular dysfunction, heart failure, myocardial infarction[9] and pulmonary edema[10].

Takotsubo syndrome is an acute and usually reversible heart failure syndrome[11]. It can be triggered by strong physical or emotional stress and is found commonly in postmenopausal women[12]. It is characterized by pathognomonic contraction patterns of the left ventricle (right ventricle may also be affected)[12,13]. Wall motion abnormality extends more than single epicardial coronary artery distribution and often results in circumferential dysfunction of the ventricular segments involved[11]. There are a number of shared factors between CO-induced cardiotoxicity and takotsubo syndrome, although the clinical aspects are not completely identical[14].

We here present a case of a 39-year-old woman who developed acute left ventricular dysfunction after carbon monoxide poisoning and emotional stress.

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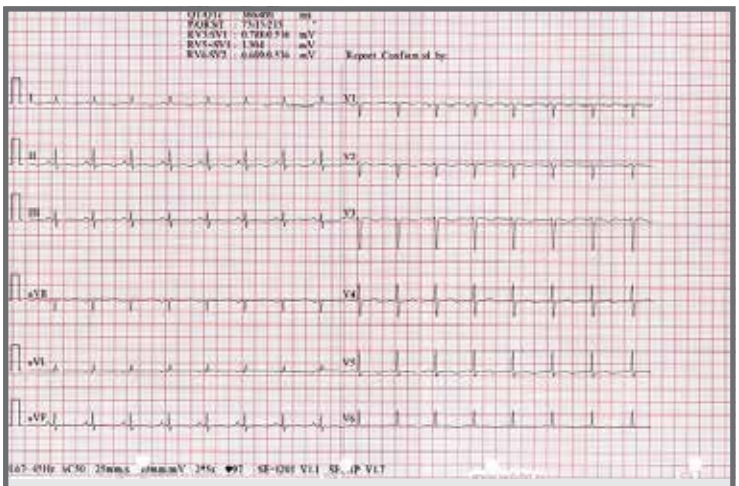

**Figure 1.** Electrocardiogram at the time of admission to hospital

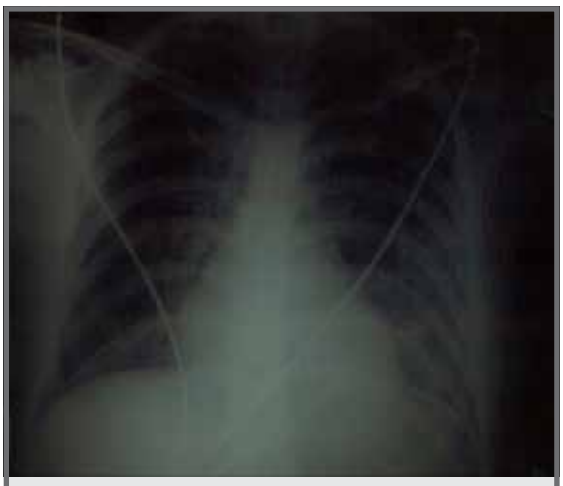

**Figure 2.** Chest radiograph at the time of carbon monoxide poisoning

## Case presentation

A 39-year-old woman was referred to the emergency department due to suspicion of natural gas poisoning. That day she just came back from the funeral of closed cousin, went to shower, when her husband found her unconscious under the shower in the bathroom. The bathroom was without windows and they were using gasoline-powered water heater. On physical examination at admission, she was comatose, blood pressure of 140/100 mmHg, heart rate was 110 beats/min and the respiration rate was 32 breaths per minute. She was intubated, ventilated and transferred to The Pulmonology intensive care unit. On admission to intensive pulmonology care unit her body temperature was 36.2°C, blood pressure of 120/90 mmHg, heart rate 106 beats/min. Initial laboratory blood gas analysis was as follows pO2 67,9mmHg, pCO2 29,9mmHg, lactate 14,62, metHgb 0,3%, pH 7,04. Complete blood count WBC 2,4x$10^9$, Rbc 3,06x$10^{12}$, Hgb 97g/l, Hct 0,28, Plt 68x$10^9$ ; carboxyhemoglobin was 12,9%. The markers of cardiac injury were elevated: Creatine kinase (CK) 2,83 µkat/l (0.0-2.25), Creatine kinase-MB (CKMB) 0,95µkat/l (cutoff 0.41), Troponin I 0,15mg/l. (cut off 0.01). Electrocardiogram showed sinus rhythm, 100 beats/min, poor R wave progression with inverted T waves in V1-V3 leads, biphasic T waves in V5 and V6 (Figure 1). Transthoracic echocardioography showed left ventricle normal in size with akinetic apex and all apical segments of the left ventricle with reduced systolic function. Ejection fraction was estimated at 45%. Chest radiograph showed diffuse bilateral inhomogen infiltrates (Figure 2). Computed tomography of the head was normal. The patient was treated with high flow oxygen in Synchronized Intermittent-Mandatory Ventilation (SIMV) mode of mechanical ventilation. One day after carboxyhemoglobin was 2,6%. and she was extubated. The markers of cardiac injury increased Creatine kinase (CK) 3.4 µkat/l (0.0-2.25), Creatine kinase-MB (CKMB) 0,38µkat/l (cutoff 0.41), Troponin I 0,42mg/l. (cut off 0.01) and she was transferred to The Clinic for cardiology for further diagnostic follow up. Coronary angiography showed normal coronary blood vessels. Regarding to all data, Takotsubo syndrome was diagnosed. She was treated with antiplatelet, angiotenzin convertase inhibitors, beta blockers and statin therapy.

She was discharged in good condition, with carboxyhemoglobin 2%. After one month ehocardiography showed left ventricle normal in size and function with preserved systolic function without wall motion abnormalities (Figure 3). Her treatment was continued with peroral antiplatlet therapy (acetil salicil acid) and beta

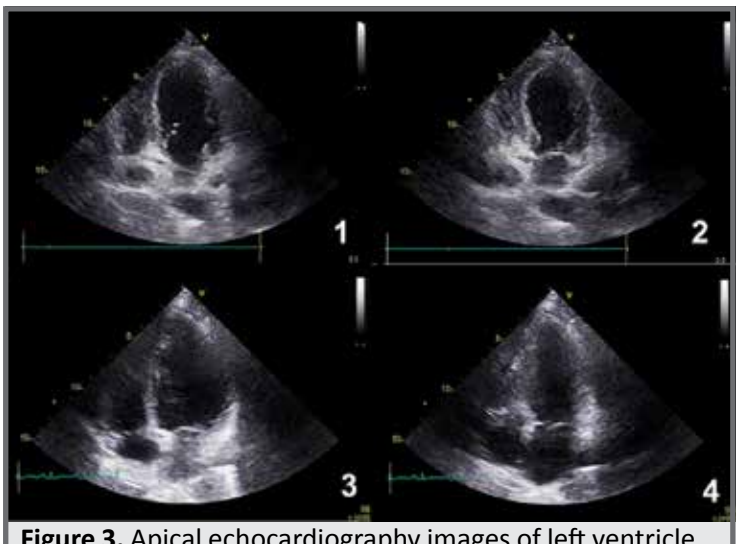


**Figure 3.** Apical echocardiography images of left ventricle

blocker for a year with complete recovery.

## Discusion

We here report a case of a 39 year old woman who developed acute left ventricular dysfunction with same echocardiographic regional wall motion abnormality pattern as in Takotsubo syndrome after exposure to CO and emotional stress.

CO induced cardiotoxicity occurs aproximatly in 1/3 of moderate to severe CO poisoning cases[15]. Different clinical manifestations with diverse outcomes, even under similar exposure conditions[16] can be seen. The clinical features and the pathophysiology of CO induced cardiac injury are not completely understood and several additional mechanisms were proposed. The cardiovascular effects induced by CO poisoning may be due to decreased cardiac output caused by cellular hypoxia, binding of carbon monoxide with myoglobin, and diminished oxygen release[17]. Ismail et el. found a link between CO exposures and oxidative stress as a possible mechanisms of CO induced cardio-toxicity. When CO binds to cytochrome oxidase in the mitochondria, the electron-transport chain and consequent ATP production are interrupted, which result in anaerobic respiration and formation of lactate and free radicals. Other effects, such as relaxation of vessel smooth muscles, inflammation, and thrombotic tendency, contribute to further injury[18-20]. Other additional mechanisms of cardiovascular toxicity may be reperfusion injury, and disruption of CO's physical functions[21,8].

Cateholamin surge was suggested as a most probable mechanism of CO induced cardiomyopathy (CMP) which results from acute CO poisoning[22]. Postmortem catecholamine levels of pericardial and cerebrospinal fluids were high in CO poisoned patients[23,24]. Catecholamine level was found to be elevated also in Takotsubo syndrome[25].

Cha et all[22] investigated the early incidence of CO-induced cardiomyopathy and its patterns and found that patients with CO poisoning and myocardial injury experienced cardiomyopathy, including reversible global, regional wall motion abnormality and a Takotsubo-like pattern[22].

Younger patients were more prone to global left ventricular dysfunction while older ones with more risk factors for coronary artery disease (CAD) had regional wall motion abnormality. Several authors reported case reports with the description of cardiovascular manifestations of CO poisoning but none didn't develop takotsubo like wall motion abnormality. Colvin end Stearnes documented ECG changes after CO poisoning[26,27]. Myocardial infarction has been reported in patients with underlying CAD[28] and in patient without preexisting CAD[29].

Lee et al[7] investigated CO toxicity on large scale database (N=8381) and found that CO poisoning is associated with higher overall risk of subsequent development of arrhythmia and CAD, but no significant correlation was found between CO poisoning and development of chronic heart failure[7].

Jung et al investegated cardiotoxicity in Six hundred and twenty-six patients with CO poisoning and found that CO induced CMP occured in 3% of CO poisoned patients. 6 patients had echocardiographic caracteristics that resembeled Takotsubo CMP and two resembeled reverse Takotsubo CMP[14].

There are several common factors between CO-induced CMP and takotsubo CMP, although the clinical features are not entirely the same.

In the Takotsubo syndrome there are a lot of unknowns in the etiology and pathogenesis that lead to this type of transient myocardial damage. The most common cause of Takotsubo syndrome is emotional stress, but the physical stress is may also cause this form of this cardiomyopathy[30]. Considering the common factors between the CO-induced CMP and takotsubo syndrome, catecholamine surge might play a central role in the development of CO-induced CMP. Less commonly, the occurrence of Takotsubo syndrome is a consequence of a combination of various causes. In our case the involvement of a catecholamine mediated mechanism caused by CO poisoning and stress might caused this left ventricular dysfunction Takotsubo like syndrome in 39 year old woman. CO poisoning haven't yet been described as a trigger for Takotsubo syndrome.

We propose that acute catecholamine surge caused by CO poisoning and stress may have initiated the development of this specific condition.

In conclusion, cardiac injury is common and needs to be evaluated in every patient with CO poisoning. In the acute stage of CO poisoning prognosis is favorable if adequate treatment with 100% oxygen is initiated on time. Still, substantial risk for subsequent cardiovascular events is higher in this population and they should be closely observed.

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## Sažetak

### *Oštećenje miokarda uzrokovano kombinacijom emocionalnog stresa i trovanja ugljen monoksidom - prikaz slučaja*

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***Uvod:*** *Ugljen monoksid (CO) je vodeći uzrok trovanja širom sveta. Centralni nervni sistem i srce imaju najveće potrebe za kiseonikom i mogu biti teško oštećeni u trovanju CO.*

***Prikaz slučaja*** *bolesnice starosti 39 godina koja je nakon snažnog emocionalnog stresa i trovanja CO upućena u Urgentni Centar. Pri inicijalnom pregledu ona je komatoznog stanja svesti, a u laboratorijskim vrednostima se registruju povišene vrednosti laktata (14.62), metHgb 0,3% i karboksihemoglobina 12,9%. U EKG-u registrovan sinusni ritam, srčane frekvencije 100/min, slab porast R talasa sa inverznim T talasima V1-V3 i bifaznim T talasima V5, V6. Transtorakalnom ehokardiografijom viđena je leva komora sa akinetičnim vrhom i svim apikalnim segmentima leve komore, snižene sistolne funkcije. Kardiospecifični enzimi su bili povišeni, urađena je koronarograija kojom se nađe uredan luminogram koronarnih krvnih sudova. Na osnovu svih parametara, postavljena je dijagnoza Takocubo sindroma. Lečena je visokim dozama kiseonika na mehaničkoj ventilaciji, oralnim preparatima acetilsalicilne kiseline, inhibitorima angiotezin konvertujućeg enzima, beta blokatorima i statinima uz potpuni oporavak. Kontrolnom ehokardiografijom, nakon mesec dana, opisuje se uredan nalaz.*

***Zaključak:*** *Trovanje CO do sada nije opisano kao precipitirajući faktor za razvoj Takotsubo sindroma. Dva riziko faktora trovanje ugljen monoksidom i stres inicirala su buru kateholamina koja je mogla da pokrene razvoj ovog specifičnog sindroma.*

***Ključne reči:*** *trovanje ugljen monoksidom, kardiotoksičnost, takotsubo sindrom*