

Severe Visual Loss Caused by Inhalational Methanol Poisoning in Fireworks Production: A Report on 3 Cases

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Case report

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Abstract

BACKGROUND

Explosion injury is a common occupational injury with fireworks production. There are few reports about the relationship of severe visual loss and acute methanol poisoning in fireworks laborers.

CASE SUMMARY

Here we report 3 patients of visual loss caused by inhalation exposure to high concentration of methanol, who were engaged in the granulation process of fireworks manufacturing industry. They presented with severe metabolic acidosis and visual impairments, accompanied with headache, chest tightness, shortness of breath, dizziness and vomiting. One patient developed bilateral blindness and two patients improved after timely hemodialysis treatment.

CONCLUSION

This case report emphasizes the risk of methanol poisoning in the fireworks industry or other factories using commercial alcohol. Early hemodialysis intervention and metabolic acidosis correction are crucial for rescuing visual impairment caused by methanol exposure. The awareness and supervision of commercial alcohol are indispensable for similar industrial manufactures.

1 Background

Fireworks manufacturing in China has nearly ten hundred years history. Occupational injuries are usually hollow organ injuries after explosion including thermal injuries, penetrating injuries due to secondary projectiles and secondary injuries like falls and burns^[1]. In the past, no occupational methanol poisoning case was reported in fireworks factories, however, recently three workers engaged in granulation process were found severe vision loss after exposure to commercial alcohol containing high concentration of methanol.

Commercial alcohol products are widely used as volatile solvents in many industrial factories. Formic acid, the end product of methanol metabolism, directly inhibit the activity of cytochrome oxidase in mitochondria and interfere with adenosine triphosphate (ATP) production. It results in histotoxic hypoxia that preferentially affects the retina and optic nerve^[2]. Methanol intoxication is very dangerous because it can cause metabolic acidosis, severe visual dysfunction, permanent neurological dysfunction, cardiovascular instability and even death. Survivors may develop ophthalmologic abnormalities, dystonia or parkinsonism^[3].

Most cases of methanol poisoning worldwide are caused by the intake of adulterated beverages containing methanol, while occupational methanol poisoning due to inhalation of steam and transdermic

absorption is rarely reported^[4]. Here, we report three cases of methanol poisoning through respiratory exposure in granulation department in fireworks factories.

2 Case Presentation

Three patients reported acute, painless, bilateral visual loss. The clinical features, biological parameters, clinical treatments and methanol concentration in work environment and commercial alcohol are presented in Table 1.

Table 1 Clinical characteristics, biological parameters, clinical treatments of patients.

Variables	Case 1	Case 2	Case 3
Clinical characteristics			
Age in years	48	56	38
Gender	male	male	male
Granulation working life spans	8 years	3 months	5 years
Vital signs			
Body temperature	37.7°C	36.7°C	36.7°C
Respiratory rate	25/min	22/min	22/min
Heart rate	100/min	74/min	82/min
Systolic/diastolic blood pressure	139/97mmHg	120/70mmHg	145/100mmHg
Biological parameters			
pH	7.09	7.28	7.26
PaO ₂	34 mmHg	126.5 mmHg	118 mmHg
PaCO ₂	39 mmHg	23.3 mmHg	15.6 mmHg
Actual bicarbonate	11.8 mmol/L	16.9 mmol/L	No test
Standard bicarbonate	9.3 mmol/L	20.1 mmol/L	No test
Uric acid	690 μmol/L	568 μmol/L	528.1 μmol/L
White blood cell count	10.18×10 ⁹	11.58×10 ⁹	17.99×10 ⁹
Percentage of neutrophils	96.1%	72.61%	91.1%
Clinical treatments			
Hemodialysis	Yes	Yes	No
Acidosis correction	Yes	Yes	Yes
Glucocorticoids	Yes	Yes	Yes
Water and electrolyte balance	Yes	Yes	Yes
Nerve nutrition	Yes	Yes	Yes
Vitamin B supplement	Yes	Yes	Yes
Hospital stays	19 days	31 days	10 days
Clinical outcomes	Left 1.0	Left 0.6	Vision loss
	Right 0.8	Right 0.6	

Methanol concentration			
In work environment (mg/m ³)	1355.8±803.0	3021.8±896.6	1097.2±114.5
In commercial alcohol (g/100mL)	79.9	79.3	96.3

Case 1

A 48-year-old male was admitted to hospital with blurred vision, chest tightness, vomiting, shortness of breath. He had engaged in fireworks granulation work and sprayed adhesive agent into granulating pellet machine by air pump for 8 years. On day 2, his vision deteriorated continuously and could not identify the content of the phone screen. The fundus examination revealed abnormal macular reflex. He was diagnosed with acute methanol poisoning, toxic optic neuropathy and type I respiratory failure. Naked vision of both eyes was 0.06. Fundus examination showed indistinct macular center concave reflection. After the treatment of hemodialysis, short-term glucocorticoids, and other symptomatic treatments, such as acidosis correction, oxygen inhalation, nerve nutrition, vitamin B supplement liver protection, water and electrolyte balance maintenance, his visual acuity had returned to normal (1.0 in the left eye and 0.8 in the right eye) on day 19.

Case 2

A 56-year-old male was admitted to hospital with progressive blurred vision, narrowed visual field, chest tightness and dizziness. Naked eye vision examination: no light perception in the right eye, and visible only at 30 cm in the left eye. He was diagnosed with acute methanol poisoning, and treated with timely hemodialysis and short-term glucocorticoids. Other treatments according to syndromes, such as acidosis correction, oxygen inhalation, nerve nutrition, vitamin B supplement liver protection, water and electrolyte balance maintenance. His bilateral visual acuity had returned to 0.6 on day 31.

Case 3

A 38-year-old male was found with severe chest pain, chest tightness, shortness of breath, and progressive blurred vision. He had engaged in fireworks granulation work for 5 years discontinuously. He couldn't see anything in 10 hours.

Fundus examination showed light reflex disappearance, mydriasis (6 mm), double papillary edema, enlargement of the optic disc cup (C/D 0.75), slightly pale optic disc, fuzzy optic disc boundaries and less thickness of macular fovea. He was treated with glucocorticoids and other symptomatic treatments other than hemodialysis. His eyesight was not improved on day 10 and finally diagnosed with bilateral nerve atrophy and blindness (no light perception) in two months.

3 Workplace Survey

Three cases came from three factories with similar scale. The granulation workshop is made with bricks without front door. Polyvinyl chloride resin, strontium carbonate, sulphur and other raw materials mixed in the granulating pellet machine in a certain proportion, then adhesive solvent (industrial alcohol containing methanol) was sprayed into machine by air pump. Each spraying 3-4 seconds, interrupted 2 minutes, continuous stirring 30-60 minutes.

Low-priced "industrial alcohol" (containing high content of methanol) were used as adhesive solvent, and the concentration of methanol in the production environment and in "industrial alcohol" seriously exceeded the government standard (50mg/m³ and 0.8g/100mL respectively) in Table 1. The working time is 8 to 10 hours per day and 5 to 6 days per week. The average daily use industrial alcohol was around 80-100 kg. The process requires workers to clean machine closely, increasing the methanol intake through the respiratory tract. Their working places is short of ventilation detoxification facilities. Workers used anti-dust mask and gloves and did not use anti-poison respirator.

4 Discussion

Methanol is widely used as a solvent in many industrial, commercial, and consumer products. In current report, 3 occupational workers suffering methanol exposure were presented with acute visual deficits and metabolic acidosis. Respiratory tract of chronic methanol intake cause blindness is a known risk^[5], however, in the past there were no methanol intoxication in fireworks manufacturers due to exposure with unqualified commercial alcohol containing excessive amount of methanol. Three patients are presented with chest tightness, shortness of breath, blurred vision, binocular visual loss, hyperuricemia and metabolic acidosis, shortly after high concentration of methanol exposure.

Typical signs and symptoms of acute methanol poisoning include metabolic acidosis, central nervous disorder, and vision abnormality caused by formic acid^[6]. Central nervous system damage is often manifested as headache, convulsion, delirium, lethargy, coma, epileptic seizure and coma. Optic nerve damage is manifested as photophobia, double shadow, visual nerve atrophy and irreversible blindness due to progressive demyelination of nerve fibers^[7], and patients with severe poisoning show permanent visual impairment^[8]. All patients in this paper developed typical clinical symptoms such as vision loss, chest tightness and shortness of breath.

All the patients were treated according treatment principles of acute methanol poisoning, include decreasing poison exposure, metabolic acidosis correction, glucocorticoids, respiratory support treatment, symptomatic treatment and vitamin supplementary. Only Case 3 developed binocular optic nerve atrophy and binocular blindness due to the absence of hemodialysis in early phase. The naked eyesight of case 1 and 2, who were treated with timely hemodialysis, reverted to normal level.

Hemodialysis timely and effectively remove methanol and formic acid, correcting metabolic acidosis and electrolyte disorder, is the most important treatment for acute methanol poisoning^[9]. Early acidosis correction and short-term glucocorticoid using are also critical measures to prevent optic atrophy. In our report, symptomatic treatment of drug treatment could not completely block methanol toxicity, while early administration of hemodialysis minimized the severity of visual loss significantly. The methanol poisoning accident in workers from granulation departments of fireworks factory was, to a large extent, ascribed to lack of management of industrial alcohol purchase, no ventilation detoxification facilities, workers' ignorance of risk of methanol and nonuse of anti-poison respirator.

Conclusions

The authors recommend measures to strengthen the supervision of fireworks manufacturing industry and execute strictly occupational inspection and supervision. Business manager and workers identified the risk of unqualified commercial alcohol and methanol, and hemodialysis, short-term glucocorticoids, and acidosis correction should be performed immediately once severe methanol poisoning occurs.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Written informed consent was obtained from the patients for publication of this Case report.

Availability of data and materials

All data generated during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

All the authors were involved in the clinical management of the cases described, drafting of the manuscript, and literature survey. All authors read and approved the final manuscript.

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