

Hydrogen peroxide is a risk factor for occupational chemical poisoning

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To the Editor: Hydrogen peroxide is a strong oxidant, which is commonly used as a disinfectant mainly in medical and chemical workplaces. Hydrogen peroxide poisoning causes brain infarction, and ingestion of hydrogen peroxide injures the upper gastrointestinal tract.^[1] Besides, food poisoning is often caused due to hydrogen peroxide. A case has been reported in China that cerebral embolism was caused by oral hydrogen peroxide poisoning.^[2] The first two cases of hydrogen peroxide poisoning caused by sterilization and disinfection in China are illustrated in this article. These two cases were caused by respiratory tract inhalation and skin contact with hydrogen peroxide in the workplace, indicating that hydrogen peroxide is a risk factor that causes occupational chemical poisoning. Therefore, it is suggested that medical institutions should strengthen their occupational health management. The collection, analysis, and release of data have been approved by the Ethics Committee of Ankang Center for Disease Control and Prevention (No. AKCDC-2020003).

Patient 1, the staff of Shiquan County Hospital, Ankang City, Shaanxi Province, has been responsible for medical device disinfection and sterilization in the hospital since 2016. The sterilizer that he used was Baixiang PS low-temperature plasma sterilizer (YZB/Jing 0008-2010, Beijing Baixiang New Technology Co., Ltd., Beijing, China; hereinafter referred to as PS). In December 2018, the patient had piercing pain of the throat and felt burning, cough, chest tightness, and other discomfort symptoms without knowing the reasons. On January 18, 2019, an engineer from the equipment supplier Beijing Baixiang New Technology Co., Ltd., identified medium leakage. In the operating room, there was no air ventilation. Although the exhaust facilities were not working properly after a PS repair, the use of PS continued. On January 20, the patient was diagnosed with pneumonia involving both lungs and bronchopneumonia. He was treated in Shiquan County Hospital and Ankang Central Hospital successively and then admitted to Xi'an Central Hospital for hospitalization.

Patient 2, the staff of the same hospital as Patient 1, has been using PS intermittently since May 2015. In December 2018, he was identified with dry mouth, piercing pain of the throat, cough, and other discomfort symptoms. According to the patient, PS malfunction was identified in the sterilization cycle on December 7, 2018, in the sterilization room, where an intense irritating odor bursted and people could not open their eyes. What is more, the irritating odor could not be denied by disposable masks. From January to March 2019, the disinfection performer frequently saw white residues on his hands and felt pain and burning in his fingers. In March 2019, he was admitted to Shiquan County Hospital and Ankang Central Hospital successively and was diagnosed with bronchopneumonia.

On May 7, 2019, Shaanxi Lifang Environmental Protection Technology Service Co., Ltd. tested the concentration of hydrogen peroxide in the Sterilization Supply Center of Shiquan County Hospital and concluded that the concentration of hydrogen peroxide in the air was within the occupational exposure limit. Before the test, the operating room was renovated, new windows were installed, a new axial-flow fan was mounted at the bottom, and an exhaust fan was installed at the top. Besides, ventilation, gas defense, and protection facilities were just finished, and the operators were equipped with gas masks and other labor protection equipment. Shiquan County Hospital provided information about the two patients' exposure to occupational disease hazards. From May 2016 to December 7, 2018, the hydrogen peroxide low-temperature plasma sterilizer was working properly in the Sterilization Supply Center. At 04:30 pm, December 7, 2018, the PS broke down in the sterilization cycle. Later, an engineer from the manufacturer came and replaced the solenoid valve on December 13. The sterilizer then continued to work properly. However, at 02:30 pm, on January 17, 2019, when the staff of the operating room handed over the loading basket to the staff of the supply room, they discovered white powders on their fingers and felt piercing pain. From December 2018 to March 2019, PS was used for sterilization for 101 pot times in total, of

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which Patient 1 performed 15 pot times, and Patient 2 performed 36 pot times. The hydrogen peroxide low-temperature sterilizer used a special hydrogen peroxide cartridge for sterilization, and the concentration was >58%. The staff was equipped with a face mask, latex gloves, disposable mask, *etc.*

On August 16, 2019, the Ankang Occupational Disease Diagnosis Agency organized a meeting with three experts, taking into account the following aspects: (1) History of the exposure to hydrogen peroxide (concentration $\geq 58\%$); (2) Workplace environmental test results meeting the applicable requirements (the operating room was equipped with windows and an exhaust fan before the test. The axial-flow fan was newly installed at the bottom. The concentration of hydrogen peroxide on the test site was qualified.); (3) Hospitalization certificate of all medical institutions, computerized tomography (CT), digital radiology (DR), and other examinations; and (4) The patients denied all family or personal history of infections when they were interviewed. With all other etiologies excluded, experts concluded that the “Diagnostic Criteria of Occupational Acute Toxic Respiratory System Diseases Caused by Chemicals” (GBZ73-2009)^[3] should be followed, and the final diagnosis was moderate occupational hydrogen peroxide poisoning.

Therefore, hydrogen peroxide is regarded as a risk factor for occupational chemical poisoning:

1. History of hydrogen peroxide leakages: The two persons affected were from the same hospital, the same occupation, the same position, and the same working environment and both of them found the onset of the disease within 1 to 2 months. Patient 1 fell sick first, followed by Patient 2. According to the documents of the hospital, the sterilization and disinfection facilities were recently renovated. Two disinfection performers were on a weekly rotation. Shiquan County Hospital confirmed PS malfunction and hydrogen peroxide leakages occurred on December 7, 2018, and January 17, 2019.
2. Damage of the respiratory system: Skin irritation, eye irritation, and burned respiratory tract may easily occur on the damaged parts. Acute bronchopneumonia was the main clinical symptom. Patient 1 had more severe condition than Patient 2. Patient 1 suffered from tachycardia, twitch, loss of consciousness, *etc.*
3. Exposure to highly concentrated hydrogen peroxide in a short term: The PS malfunction caused leakages of high-concentration hydrogen peroxide. The operating room was not equipped with any effective air ventilation or exhaust system. Besides, the disinfection performers were not wearing protective devices. As a result, they inhaled a high dose of highly concentrated hydrogen peroxide in a short term. Consequently, they suffered from piercing pain in the throat, chest tightness, cough, and general malaise.
4. Apparently, there was a correlation between the onset of the disease and the exposure to hydrogen peroxide. Occupational health examination was normal over the years before the onset of the disease; but accidental exposure to high-concentration hydrogen peroxide in the workplace caused acute respiratory system damage,

which confirmed the characteristics of acute occupational poisoning.

Hydrogen peroxide is a chemical oxidant, which is extremely unstable under normal temperature and is extremely easy to break down into oxygen and release heat. Generally, low-concentration (3%) hydrogen peroxide is mainly used for medical disinfection, whereas high concentration (>10%) is for industry use. Thirty percent of hydrogen peroxide is corrosive and may cause damage to the skin, mucosa, and other local tissues. Thirty-five percent of hydrogen peroxide can fully decompose into 3.5 L oxygen within 30 min.^[4] Although most inhalational exposures cause little more than just coughing and transient dyspnea, inhalation of highly concentrated hydrogen peroxide can cause severe irritation and inflammation of mucous membranes, with the symptoms of coughing and dyspnea. Shock, coma, convulsions, and pulmonary edema may occur in 24 to 72 h after exposure to highly concentrated hydrogen peroxide.^[5] Therefore, hydrogen peroxide is a risk factor.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) or his/her guardian has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients or his/her guardian understand that his/her/their name(s) and initials will not be published and due efforts will be made to conceal his/her/their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

None.

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