Occupational induction of hypersensitivity after an accidental exposure to chloromethylisothiazolinone and methylisothiazolinone (CMI/MI) in an industrial worker

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A process worker in a paper chemical plant developed an immediate local dermal irritation and delayed bullous dermatitis due to induction of hypersensitivity following an accidental exposure to chloromethylisothiazolinone and methylisothiazolinone (CMI/MI) biocide. Contact allergy to the isothiazolinone mixture was confirmed by skin patch testing. The dermatitis healed in four weeks, and the worker was advised to avoid all CMI/MI containing products. In a one-year follow-up he did not present with any further skin symptoms. Preventive measures are important for avoiding induction of hypersensitivity to concentrated CMI/MI solutions in industrial workers.

Key words: Allergic contact dermatitis; biocide; chloromethylisothiazolinone (CAS 26172-55-4); methylisothiazolinone (CAS 2682-20-4); occupational exposure; chemical industry; patch test.

INTRODUCTION

The isothiazolinone mixture, 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one (CMI/MI) is a well-known contact sensitizer. Because of its superb antimicrobial qualities, even at very low concentrations, this preservative has gained wide popularity. Despite its sensitizing properties, products containing CMI/MI are still used both in industrial (Kathon® LX) and cosmetic (Kathon® CG) applications. The industrial applications of Kathon® LX include polymer and latex solutions, dispersed organic pigments, adhesives, textile processing fluids, inks and printing fluids.

We present a one-year follow-up of a worker in whom an accidental exposure to concentrated Kathon® LX induced hypersensitivity to CMI/MI.

CLINICAL FEATURES

The patient was 56-year-old male process worker who had six years of work experience in the same styrene-butadiene latex plant. Since 1988 he had suffered from intrinsic bronchial asthma and had inhaled corticosteroid medication continuously. A chest radiograph in 1992 had shown bilateral pleural calcification caused by earlier exposure to asbestos. No permanent decrease in spirometric values such as forced expiratory volume in one second and forced ventilatory capacity had developed. He had no history of any earlier allergic disorders or dermatitis.

In December 1996 while at work, he received a splash of concentrated CMI/MI (Kathon® LX) solution on his right arm and foot while he was opening a blocked-up hose coupler. The splash resulted in immediate redness of the affected skin but the worker continued his work without washing his skin, or removing his contaminated clothing. The redness of the affected skin disappeared in two days following the accidental exposure to Kathon® LX biocide. However, the contaminated skin areas began
to itch ten days after the accident, and in spite of topical treatment with momethasone cream, in 12 hours an oedematous eczema appeared on the contaminated skin areas resulting in blistering in 36 hours (Figure 1). The blisters were unusually large, raised 1.5 cm above the skin, and were incised on the second day after their appearance. The lesions resolved in two weeks leaving some residual pigmentation for twelve months. With this dermatitis the worker had no associated respiratory or general symptoms, but due to the eczema and blisters he had 16 days of sickness absence in total.

After four months, a patch test with 0.02 % CMI/MI (active ingredients at 200 parts per million) supplied by Chemotechnique Diagnostics AB (Malmö, Sweden) was performed on the back of the patient using the Finn Chambers® (Epitest Ltd., Hyrylä, Finland). The patch was removed after two days and the test was read on the fourth day. At the reading, a typical allergic patch test reaction, a papulovesicular infiltrated erythema (+++), was seen on the skin that had been in contact with CMI/MI.

The patient continued his work at the styrene-butadiene latex plant. At one year's follow-up, he did not present with any skin symptoms, and had not developed any work-related respiratory symptoms or conjunctivitis.

**WORKPLACE VISIT**

The present paper chemical plant produces styrene-butadiene latex by using an emulsion polymerization process. Briefly, the process can be described as follows: styrene, butadiene, soap, water, modifier, and the components of the activation system are pumped into a reactor train at a controlled rate. The reaction is performed in eight well-agitated reactors with a size ranging from 10–30 m³. When the target conversion is reached, the reaction is stopped and unreacted monomers are recovered. The latex is stored before being pumped to coagulation. The biocide is added to latex before coagulation.

Two types of biocide were used in the present plant, one of which was Kathon® LX. This biocide was added to the end product with automated injector pumps. Sufficient product information concerning the chemicals in use with preventive and safety measures was available. However, during the accident the present process man was performing a maintenance task, resolving a problem he was not trained in. After the accident, a visit to the workplace was arranged to observe the specific work activities and assess the safety of using Kathon® LX. As a health and safety measure, an education programme for the workers was planned, plastic cover for the protection of chemical splashes was recommended, and personal protection gloves and face masks were given to the workers. Due to the lack of biocide duplicating the properties of Kathon® LX, the management was not able to replace the chemical totally in the process after the accident.

**DISCUSSION**

A single exposure to a concentrated solution of CMI/MI may result in delayed burns and primary dermal sensitization. Occupational risk from CMI/MI sensitization concerns process and maintenance workers of plants utilizing these chemicals in industrial processes. In the present case, a delayed dermal inflammation started 10 days after heavy exposure to CMI/MI and was apparently caused by an induction of hypersensitivity to CMI/MI because the patient had not had any skin troubles before. In industry, protective measures to avoid chemical splashes on clothes and skin are essential in preventing sensitization to strong sensitizers such as CMI/MI. Concentrated CMI/MI biocide products are labelled and marketed with the warning that they are strong irritants and corrosive to mucous membranes, and require the use of protective clothing and immediate cleanup after spills. Despite these warnings, the present patient continued his work because no remarkable skin troubles were noticed after the accident. Recently, tapering courses of oral prednisone have been used within 48 hours of exposure, but sensitivity to CMI/MI has still developed. In the present patient, the dermal inflammation did not react to topical corticosteroid treatment. The results suggest that steroids have little effect on the sensitization phase once exposure has occurred.
In processes where reactive allergenic chemicals are used, repeated information on sensitizing chemicals and their careful handling, as well as the correct use and care of protective gloves is necessary for all potentially exposed workers. This education can be given by occupational health care professionals during a periodic health examination.

Some cases of airborne contact dermatitis due to CMI/MI have been reported. Despite returning to work at the latex plant where Kathon® LX was still in use, the worker presented no skin symptoms of the face, neck or distal upper arms at work. This suggests that when an emulsion polymerization process for styrene-butadiene latex is used, the level of indoor exposure to aerosolized CMI/MI seems to be below the limit which elicits allergic dermatitis in a pre-sensitized worker. Measurements of indoor air to detect the level of aerosolized CMI/MI concentration were not performed in the workplace. During a one-year follow-up, the present worker developed no work-related cough, dyspnea, rhinitis or conjunctival symptoms. He had no mucosal symptoms except mild asthma. The sensitization to CMI/MI did not result in worsening of his pulmonary functions or bronchial exacerbation at work. Neither did any of his co-workers report any work-related skin or mucosal symptoms in the present workplace.

In 1980s, the increased use of CMI/MI among cosmetic manufacturers resulted in a rapid increase of contact allergy to this preservative in Finland. In 1991, a multicentre study indicated that the mean prevalence rate of sensitivity to CMI/MI in Europe was 3% among dermatologic patients tested because of suspected contact allergy. In USA, a follow-up showed that sensitization to CMI/MI has not changed from 1989 to 1992. According to the leading manufacturer of CMI/MI and the Cosmetic Ingredient Review expert panel, the range of 10–15 ppm CMI/MI is safe for cosmetic products and unlikely to cause de novo sensitization in humans during normal use.

In conclusion, exposure to concentrated solutions of CMI/MI can induce hypersensitivity on the skin after a single exposure. Education of workers is essential to prevent the risk of sensitization. In processing styrene-butadiene latex, airborne exposure to CMI/MI seems to be below the limit of eliciting any allergic reaction in pre-sensitized individuals.

REFERENCES
